New Scientist

WEEKLY 14 May 2022

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CLASSIFYING ANIMAL INTELLIGENCE

ABORTION LAWS AND REPRODUCTIVE HEALTH

THE MATRIX INSIDE YOU

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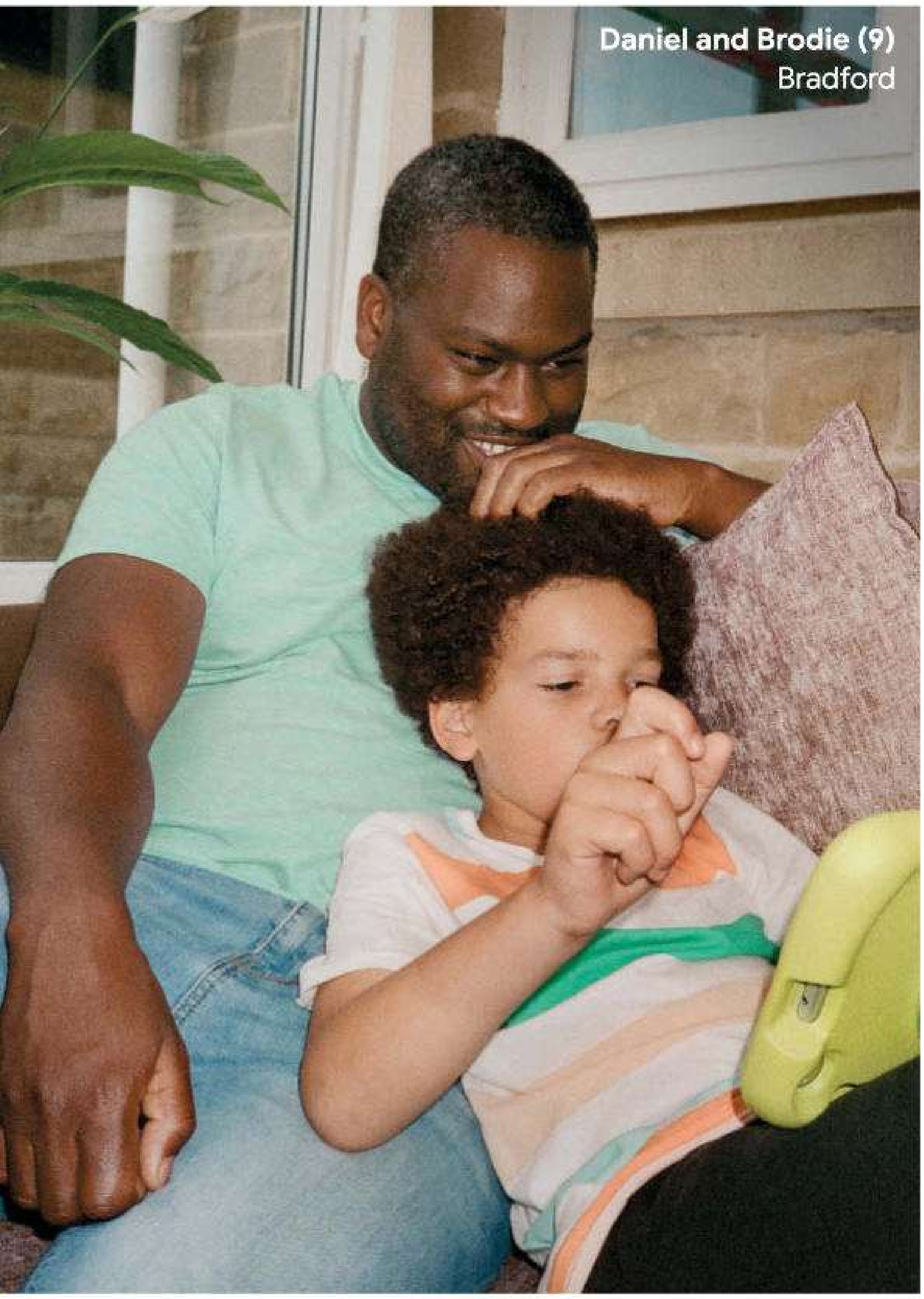

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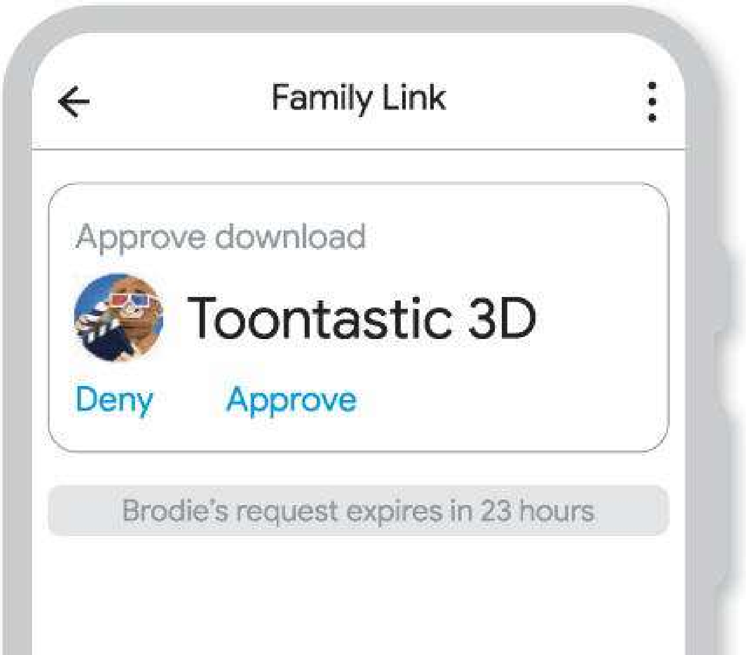

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Dinosaur hunting in the Gobi desert: Mongolia

Join us on a thrilling expedition to find dinosaur remains in the beautiful wilderness of the Gobi desert with specialists from the Mongolian Institute of Paleontology and Geology. Participate in live prospecting and fossil digging, plus visit the Flaming Cliffs where the first ever dinosaur eggs to be discovered were found. From 27 August, 15 days for £6495.

newscientist.com/tours

Virtual event

Fantastic numbers and where to find them

Leading physicist and YouTube star Tony Padilla takes us on an irreverent tour of the most extraordinary numbers in physics, using them to build a picture of how the universe works. He demonstrates how numbers are key to unlocking black holes, the holographic principle and the problem of the cosmological constant. Watch at 6pm BST on 23 June or on demand.

newscientist.com/events

Podcast

Weekly

The team discuss the dramatic impact that overturning Roe vs Wade could have on reproductive rights. They also discover that substituting a fifth of the meat in our diet with microbial proteins would more than halve global deforestation rates. Plus, worm invasions and a chat about why space needs our protection.

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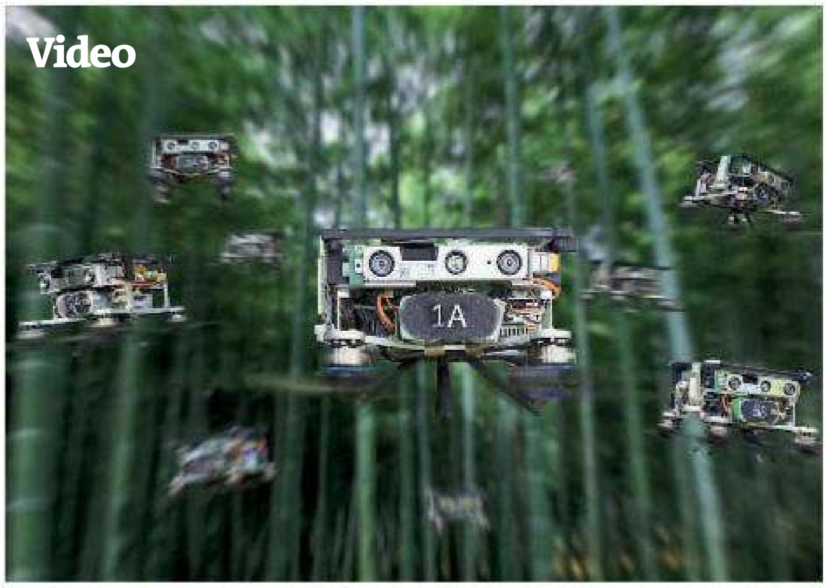
Flaming Cliffs What will you find at Mongolia's famous dinosaur site?



YUMAN GAO AND RUI JIN

Safely does it Drones avoid complex obstacles with a tech upgrade

Video

Safe swarming

Watch as 10 drones swarm through the woods without crashing into one another or the environment. The flying robots were able to plan a safe path through the trees thanks to the help of Chinese researchers, who reduced the size and hardware requirements of the drones while maintaining their computational nous.

youtube.com/newscientist

Newsletter

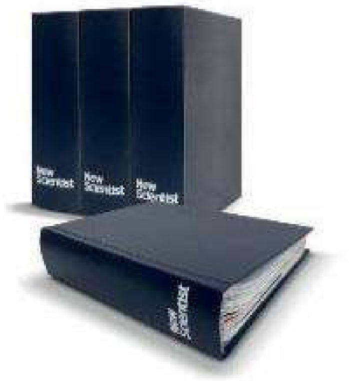
Launchpad

Reporter Leah Crane marvels that US aerospace company Rocket Lab managed to use a helicopter to catch a rocket booster falling from space. Plus, she explains how a new image of Mars is helping engineers fine-tune equipment for the next Mars landings, and outlines how you might ride a bike on the moon.

newscientist.com/launchpad

Newsletter

> **"Rocket Lab used a helicopter to catch a rocket booster falling from space. Let's discuss"**



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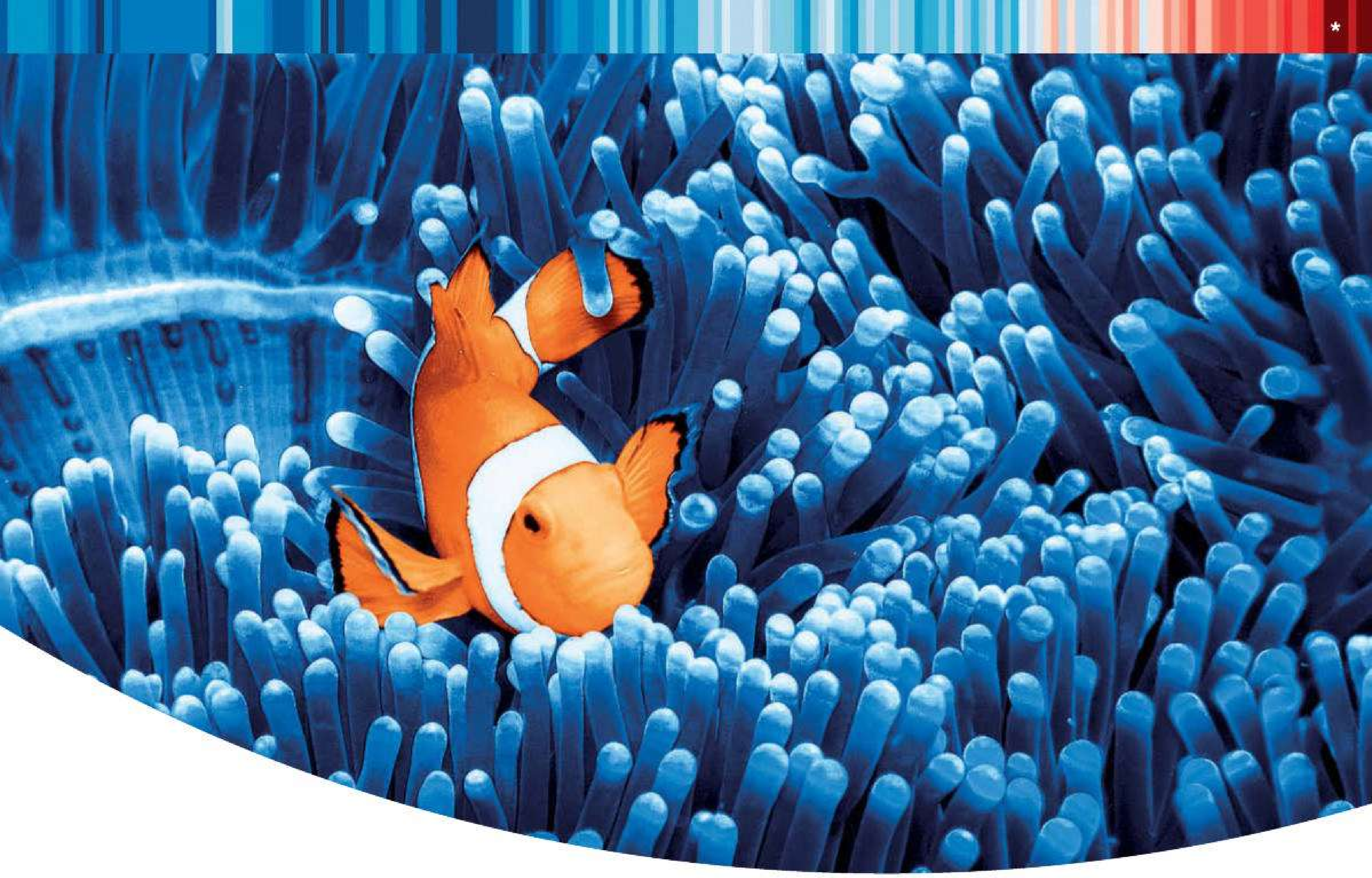

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WE'RE LOOKING FOR THE *best ideas in the world* ON BEHALF OF OLDER PEOPLE

The Ryman Prize is an international award aimed at encouraging the best and brightest thinkers in the world to focus on ways to improve the health of older people.

The world's ageing population means that in some parts of the globe – including much of the Western world – the population aged 75+ is set to almost triple in the next 30 years.

Older people face not only the acute threat of COVID-19, but also the burden of chronic diseases including Alzheimers and diabetes.

At the same time the health of older people is one of the most underfunded and poorly resourced areas of research.

To stimulate fresh efforts to tackle the problems of old age, we're offering a NZ$250,000 (£130,000) annual prize for the world's best discovery, development, advance or achievement that enhances quality of life for older people.

The Ryman Prize is awarded each year by the Prime Minister of New Zealand. It was first awarded in 2015 to Gabi Hollows, co-founder of the Hollows Foundation, for her tireless work to restore sight for millions of older people in the developing world.

Since then world-leading researchers Professor Henry Brodaty, Professor Peter St George-Hyslop, Professor Takanori Shibata, Dr Michael Fehlings and Professor Miia Kivipelto have all won the prize for their outstanding work.

In 2021 Professor Kenneth Rockwood, a Canadian geriatrician, academic and anti-ageism campaigner whose research into frailty has had a huge impact, was awarded the prize by the Right Honourable, Jacinda Ardern, Prime Minister of New Zealand.

If you have a great idea or have achieved something remarkable like Kenneth and our six other prize winners, we would love to hear from you.

Entries for the 2022 Ryman Prize close at 5pm on Friday, July 15, 2022 (New Zealand time).

Go to **rymanprize.com** for more information.

A dangerous beginning

Ending abortion protections in the US will drive inequality and threaten public health

THE right to end a pregnancy has been protected in the US for nearly 50 years. In a matter of weeks, that may change. The country's highest court is poised to overturn the landmark 1973 Roe v Wade decision. This would be disastrous for public health and equality more broadly.

The US already has the highest maternal mortality rate of any wealthy nation, with 23.8 deaths per 100,000 live births. In the UK, it is 8.8 deaths per 100,000 live births.

Given the significant health risks associated with pregnancy and childbirth, forcing more people to carry unwanted pregnancies and give birth means forcing them to face those dangers. Those who seek and are denied abortions also report higher levels of anxiety, lower self-esteem and poorer quality of life compared with those who are able to obtain one.

Things are particularly worrying when you look at existing outcomes for US minority groups, especially Black women, whose maternal mortality rate is nearly three times that of white women.

Health insurance coverage is also lower among minority groups, affecting access to more expensive, long-lasting forms of contraception, such as intrauterine devices or implants, increasing the risk of unintended pregnancy. Black women make up 28 per cent of those seeking abortions in the US each year, despite being just 14 per cent of the nation's female population.

> "Forcing people to give birth means forcing them to face significant health risks"

If abortion is restricted or banned in more than half of US states (see page 14), only those with the means to travel to a place where it is legal will be able to have the procedure done safely without fear of prosecution. Abortion is one of the safest gynaecological procedures, but when performed in unsanitary conditions or by untrained providers, it can be deadly.

The consequences for disadvantaged groups will be severe, and it may only be the beginning. Millions of people will lose the option to have an abortion in their home state if Roe v Wade is overturned. Some conservative lawmakers have already made noises about restricting access to forms of contraception, including IUDs and the morning after pill.

The end of the protections under Roe v Wade could start the unravelling of many hard-fought rights. ▮

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Endangered vaquitas aren't doomed to extinction **p21**

LALO DE ALMEIDA/FOLHAPRESS/PANOS

Environment

Amazon deforestation

Lax law enforcement has allowed huge numbers of trees to be cut down in the Brazilian rainforest, reports **Adam Vaughan**

THE Amazon rainforest in Brazil has suffered its worst-ever April deforestation rate since 2016, according to modern satellite records, months ahead of a general election where environmental protections are expected to be a key dividing line.

The area cleared almost doubled year-on-year, from 579 square kilometres in April 2021 to 1012 square kilometres last month. The losses are "bleak", tweeted Tasso Azevedo, the former head of Brazil's forest service.

The destruction follows several years of rising deforestation rates under President Jair Bolsonaro, who has argued Brazil has a right to exploit the forest. Brazil was responsible for 40 per cent of forest cover loss in the tropics in 2021.

"The continued deforestation highs are a direct result of President Bolsonaro's sabotage of environmental law enforcement in Brazil," says André Freitas at Greenpeace Brazil. He adds that only 2 per cent of deforestation alerts have been investigated by authorities in recent years.

Mark Parrington at the European Earth observation programme Copernicus says satellites detected above-average fire emissions in late April, the start of the peak deforestation "season". "If it follows the typical seasonal trend in daily emissions, it could be one of the highest April to May totals for quite a few years," he adds.

The accelerated pace of deforestation comes despite Brazil having promised to halt deforestation by 2030 in a high-profile pledge made at 2021's COP26 climate summit.

> "The deforestation highs are a direct result of President Bolsonaro's sabotage of protections"

But the deforestation figures should be treated with some caution as they come from the Brazilian space agency's DETER satellite programme. This is a relatively low-resolution system designed to help authorities discover illegal forest clearances, compared with one that tracks annual changes to forest cover. ▮

Climate change

We could exceed 1.5°C by 2026

THE UK Met Office has warned there is an almost 50-50 chance the world will briefly overshoot its crucial 1.5°C climate change target within the next five years.

The Paris Agreement set an aim to limit global warming to 1.5°C above pre-industrial levels, a threshold seen as vital to limiting the worst impacts of global warming on people and ecosystems. That aim would only be missed if a temperature rise is sustained over a couple of decades.

The Met Office's climate models estimate there is a 48 per cent chance that the average global temperature of any year between 2022 and 2026 will be more than 1.5°C above pre-industrial levels. For the previous five-year period, 2017 to 2021, the chance was less than 10 per cent.

The prediction shows how close the world is to failing on its climate goals. "One year's exceedance doesn't mean anything; it just means that we're getting closer and it's a warning that we need to really double up on the efforts to cut carbon dioxide and reduce our use of fossil fuels," says Leon Hermanson at the Met Office, part of the team behind the report, *Global Annual to Decadal Climate Update*, made for the UN's World Meteorological Organization.

The report also finds there is a 93 per cent chance that one of the next five years will eclipse 2016 as the warmest on record. ▮

AV

Climate change

Life during India's heatwave

Extreme spring temperatures show the need for long-term heat action plans as India's climate warms, reports **Payal Dhar**

INDIA is reeling from a fresh heatwave that began on 7 May. It follows weeks of extreme heat throughout much of the north of the country in March and April that saw temperatures reach more than 46°C and approach 49°C in neighbouring Pakistan.

"This kind of heat is not unknown in north India during the summer before the monsoon," says Ulka Kelkar, director of the World Resources Institute's climate programme in India. "The difference this time is that it has come earlier than expected, when agricultural operations or even schools are in full swing, so more people get exposed and may not be prepared."

The monsoon that typically slakes the extreme heat of summer is still weeks away. On 5 May, India's prime minister, Narendra Modi, urged states and federal territories to prepare new heat action plans in the face of extreme temperatures.

Every year, temperatures in the region soar to the mid to high 40s, usually in the months of May and June. In some parts of Pakistan, they can touch 50°C. Above 40°C, the human body is at risk of muscle cramps, swelling, exhaustion, dizziness and fainting, and heatstroke.

Hemraj, a gardener at the Shiv Nadar University campus in Greater Noida, Uttar Pradesh, near Delhi, is used to preparing for a heatwave every summer. But "summer came early this year", he says. Hemraj has been working since the late 1990s and seen the summers get hotter and longer over the decades.

At 2pm, close to the hottest part of the day, Hemraj is still outdoors, working. "I don't feel the heat or the cold," he says. "I focus on my work instead." A few minutes later, he talks about how leaves burn in the sun and how he can feel the heat of the ground through his shoes. He drinks lots of water, keeps his head covered and takes breaks to beat the heat. "People who sit in air-conditioned rooms can't imagine being outside in this heat, but we are used to it," he says.

"People in air-conditioned rooms can't imagine being outside in this heat, but we are used to it"

Rani, who runs an ironing service in a south Delhi residential neighbourhood, works from an open shelter made of a tarpaulin sheet and uses a traditional hot-coal iron. She is her own boss and can choose not to work on extremely hot days, but that means a day without wages. The situation is similar for Hussain, a garbage collector in Delhi who goes from house to house daily in his cycle-cart, picking up household rubbish. His contract means he only gets paid on the days that he works.

India is expected to experience hotter and longer heatwaves as a result of climate change. This will see more people having to work in dangerously hot conditions. A 2020 study looking at heat stress and associated work performance predicts a productivity decline of 30 to 40 per cent across India by the end of the century (*Scientific Reports*, doi.org/htcr). "[This poses] great challenges to the country policy makers to design the safety mechanisms and to protect people working under continuous extreme hot weather conditions," the authors write.

At the moment, a heatwave in India is generally declared when temperatures reach a certain level above the 30-year average. For example, existing heat action plans for Indian cities are usually triggered when it becomes hotter than 40°C, says Kelkar. "However, the focus [should be] to reach the people ahead of the heatwave actually starting, and to reach people at a very local level."

Time to plan

Taking action as temperatures rise isn't enough, says Kelkar. Instead, long-term action plans are needed to prepare communities in South Asia for climate extremes, she says. This needs to start with awareness at community level, she says, and include information on recognising the early signs of heatstroke, as well as providing access to medical attention, shelters and water. In rural regions, arrangements are needed for livestock as well as people.

India must also look at the way it builds cities and infrastructure. "We're [creating] heat islands as a result of the materials being used and the way we are building," says Kelkar, which is at the expense of green cover and water bodies. Policies for green building design are urgently needed and must be enforced, she says. Where cooling is powered by electricity, it should come from renewable sources.

Focusing on the big picture, however, cannot be at the cost of individuals. "It doesn't matter how hot it gets, I have to work," says Hussain. "I'm surviving because of the kindness of individuals, not because the system or my employers help me out in this heat."

SANCHIT KHANNA/HINDUSTAN TIMES/SHUTTERSTOCK

Temperatures reached 39°C in New Delhi, India, on 2 May

How quickly can you catch covid-19 again?

A prior infection appears to offer some protection, but it is unclear for how long, or whether reinfections are guaranteed to be mild, finds **Clare Wilson**

AS THE omicron variant of the coronavirus continues to spread, many people who have already contracted the virus once are picking it up again. But a key question remains unresolved: for how long after a covid-19 infection are people likely to be protected from reinfection?

A lot hinges on the answer, as new omicron subvariants called BA.4 and BA.5 are on the rise in South Africa. It is still unclear if this will translate into a large wave in that country or elsewhere.

With some infections, such as measles, if someone has had the disease once, they rarely catch it a second time. Coronaviruses don't seem to provoke such "sterilising immunity", although a first infection does reduce people's risk of a second one.

In unvaccinated people, for instance, a first infection cuts people's risk of a second one by about 85 per cent, according to a large US study. This is similar to the level of protection provided by two doses of the mRNA covid-19 vaccines and was stable over the nine months of the study. "I was surprised that we found such a high level of protection," says Jessica Ridgway at the University of Chicago.

Ridgway's study was done while the delta variant was the dominant virus strain circulating globally, though. Omicron causes more reinfections than past variants, because of mutations in its spike protein that help it to evade immunity. During the UK's recent omicron wave, reinfections were 16 times more likely than during the previous delta wave, according to the Office for National Statistics (ONS).

This still doesn't tell us how long most people can expect to be protected before having another covid-19 infection, however.

PATRICK T. FALLON/AFP VIA GETTY IMAGES

Masked and maskless people at an airport in Colorado last month

Indeed, it isn't yet possible to calculate this figure with any accuracy, although we can get a hint from existing data. For instance, the ONS has looked at reinfections in the UK, covering the pandemic from its beginning up to mid-December 2021, when omicron had been dominant for several weeks. The study found that the interval between reinfections ranged from 90 to 650 days, with the average being 343 days, or nearly a year.

But these figures could have two sources of error. First, they could be too low an estimate because many people haven't yet had two infections. When they have, and their data can be added to the calculations, the average interval between infections should rise.

Second, some reinfections will be going unrecognised, as the ONS classes someone as being reinfected only if more than 90 days has passed since a previous infection confirmed by a PCR test. That is because these tests can lead to false-positive results within this period. This approach "identifies the majority of reinfections while excluding those people who may still have virus detected for some time after their initial infection", says Helen Campbell at the UK Health Security Agency.

But reinfections within 90 days can happen, as shown by a study in Denmark, a country that experienced a surge of omicron cases beginning in November 2021, caused by peaks of omicron subvariants BA.1 and BA.2 merging into each other. Morten Rasmussen at the Statens Serum Institute in Copenhagen, Denmark, and his colleagues managed to find 47 people who were infected with both subvariants, with intervals of between 20 and 60 days. "It does seem to be rare," says Rasmussen.

20
One of the shortest recorded gaps between reinfections, in days

343
The average reinfection interval according to UK figures, in days

650
The longest reinfection interval according to UK figures, in days

A reason why there is so much interest in the reinfection question is concern that repeated covid-19 infections might have a cumulative toll on people's health. Studies suggest that subsequent bouts of coronavirus are less severe than the first one. Research in Qatar, for instance, found that second infections were linked to a 90 per cent lower chance of hospitalisation or death than initial ones.

But that is no guarantee of safety, says Stephen Griffin at the University of Leeds, UK, who is a member of Independent SAGE, a group that offers independent scientific advice on covid-19 to the UK government. It is still unclear how likely people are to develop long-lasting symptoms from an infection, but if someone catches covid-19 several times then, overall, their chance of long covid may rise, says Griffin. "The less likely things are more likely to happen with a greater number of times you get reinfected," he says.

Rasmussen believes it is too soon to know the effect of repeat infections on people's risk of long covid or anything else. "It feels like [the pandemic] has been going on for hundreds of years, but it's really been an incredibly short amount of time," he says. "It does not look as if it's going to go away." ▮

Medicine

Virus found in pig heart recipient

The first person to receive a pig's heart has died after a porcine-specific viral infection was discovered within the organ, but the cause of death is unclear, reports **Michael Le Page**

UNIVERSITY OF MARYLAND SCHOOL OF MEDICINE

The pig heart transplant in progress at the University of Maryland

A PIG virus may have contributed to the death of the first person to receive a heart transplant from one of the animals.

David Bennett died in March, aged 57, two months after a transplant operation. Bennett, who had severe heart failure, was deemed too sick to receive a human heart and received the pig organ on a compassionate basis. Ten genetic changes were made to the pig that supplied the organ to prevent it being rejected, with four pig genes deleted and six human genes added.

Bennett initially seemed to be doing well. However, the doctors behind the transplant have now revealed that they tried to treat a pig cytomegalovirus infection in the weeks before his death.

Transplant surgeon Bartley Griffith at the University of Maryland announced the presence of the cytomegalovirus in a talk to the American Society of Transplantation on 20 April. "We are beginning to learn why he passed on," he told *MIT Technology Review*.

MIT Technology Review reports Griffith as saying that the viral infection may have been why the pig heart failed, rather than Bennett's immune system rejecting the organ. "There is no evidence that the virus caused an infection in the patient or infected any tissues or organs beyond the heart," says a spokesperson for the University of Maryland.

Cytomegaloviruses are related to the herpes viruses that cause cold sores and shingles. Once animals are infected, the viral DNA remains inside some cells. The immune system normally keeps the virus in check, but if an animal is weakened, the virus can reactivate and cause further infections.

Bennett would have had no immunity to porcine cytomegalovirus, giving the virus a chance to reactivate and infect the transplanted heart. The virus doesn't infect human cells, says Joachim Denner at the Free University of Berlin in Germany. Bennett was also on immunosuppressing drugs, which may have prevented his immune system from responding fully.

The virus was first detected in blood taken 20 days after Bennett's transplant. The team tried various treatments, including a drug used to tackle human cytomegalovirus infections, called cidofovir, and Bennett seemed to be recovering before a rapid deterioration in his condition. When his immune system began responding to the virus, it may have triggered an inflammatory response known as a cytokine storm, damaging the heart, says Griffith.

In 2020, Denner and his colleagues found that baboons don't live as long if they develop porcine cytomegalovirus infections after pig heart transplants. But nobody can say for sure to what extent the virus contributed to Bennett's death, says Denner. "He was very, very ill."

Pigs bred to provide organs are raised in special clean facilities so they are free from pathogens. The failure to detect the virus before the transplant may have been due to tests not being sensitive enough, says Denner. He has developed sensitive tests for detecting porcine cytomegalovirus, which his lab used in 2016 to spot the virus in pigs raised for research. These tests came back positive even on samples that were negative when checked by labs in the US.

10

Number of gene changes to make a pig heart ready for transplant

"The testing referenced by the researcher in your article is experimental [and] was not available to our surgeon-scientists at the time of this transplant," says the Maryland spokesperson, when asked if these tests were used by Griffith's team.

Detecting latent infections – where the viral DNA is sitting in a few cells and no viruses are being produced – is harder than identifying active infections, but it can be done in two ways. The first is to look for the viral DNA in blood or tissue samples. The second is to look for antibodies to the virus. Denner's lab uses both methods. It is unclear which tests were carried out before Bennett's transplant.

"The healthy donor pig used for the xenotransplant was screened for pathogens multiple times. It was tested just before shipment to Maryland, and just before the transplant a few days later. The testing followed protocols that were accepted by the US Food and Drug Administration (FDA). As plans move forward for future clinical trials, more sophisticated testing techniques are being developed and validated to ensure this virus does not go undetected," says the Maryland spokesperson.

If the virus contributed to Bennett's death, rather than it having happened because his immune system rejected the organ, the results of Denner's baboon study suggest that other transplant recipients may live longer if given virus-free hearts. Pigs can be guaranteed to be free of porcine cytomegalovirus by weaning the animals 24 hours after birth, says Denner.

Revivicor, a subsidiary of United Therapeutics, developed the pig behind Bennett's transplant and hasn't commented on the detection of the virus. There is no evidence of wrongdoing by the companies. Neither firm responded to *New Scientist*'s requests for comment before publication. ■

ATEM Mini Pro model shown.

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Analysis Cryptocurrency

Will the Central African Republic's bitcoin experiment flop?

The second country to make the cryptocurrency legal tender may end up benefiting criminals and warlords most, reports **Luke Taylor**

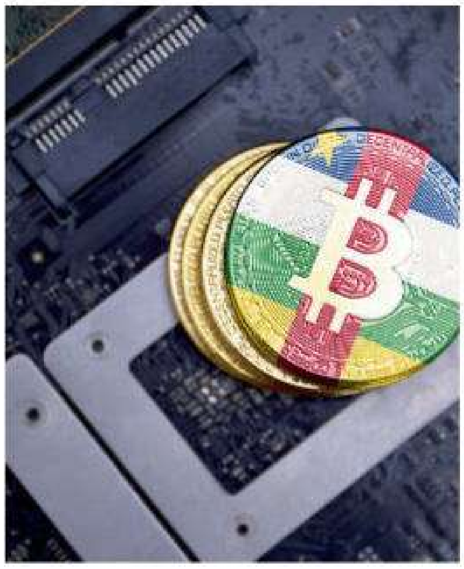
THE Central African Republic (CAR) has made bitcoin legal tender, but economists say the project has little chance of success.

As of 20 April, the cryptocurrency must be accepted alongside the existing currency, the CFA franc, in a move that aims to put the war-torn nation's economy "on the map of the world's boldest and most visionary countries", the CAR presidency said in a statement.

> "It will drive corruption and make abuses by mercenary groups more viable"

It is only the second country to do this, after El Salvador led the way in September 2021. However, that nation's experience doesn't bode well for CAR's move.

El Salvador's president Naybib Bukele introduced bitcoin with the promise that it would boost the economy, help people without access to banking facilities and save money on remittances. But the roll-out of its national bitcoin app, Chivo, is failing, prompting the International Monetary Fund to urge the country to ditch the experiment as debt grows.


SHUTTERSTOCK/ESFERA

An artist's impression of bitcoins with the Central African Republic flag

Chivo has had "virtually no downloads" so far in 2022, according to a study by Fernando Alvarez at the University of Chicago and his colleagues, with the median app user only storing and transferring US dollars. And just 1.6 per cent of national remittances were received in digital wallets in February, says El Salvador's central bank.

This failure isn't due to lack of commitment. No country has ever launched a secondary currency with such financial, legal and political backing and failed, says Alvarez.

New Chivo users receive a $30 sign-up bonus, equivalent to 0.7 per cent of average annual income in El Salvador. The government covered transaction fees and subsidised fuel purchases in bitcoin, too, but more than 60 per cent of those who got the app ditched it after withdrawing the $30 bonus, the study found.

Advocates often cite poor uptake for why bitcoin isn't widely used, but El Salvador's experiment suggests this is a fallacy, says Alvarez.

"Even with a big push, apparently bitcoin, given the limitations we have right now, is not such an effective means of payment," he says.

CAR's decision to adopt bitcoin rather than the more-favoured US dollar may indicate a greater desire to swap state-backed currencies for cryptocurrencies, says Alvarez. But almost all development metrics, including education and poverty rates, suggest it will be harder for bitcoin to stick in CAR than in El Salvador, says Billy Jack at Georgetown University in Washington DC. As bitcoin is a decentralised digital currency, it requires internet access and a smartphone. Only 55 per cent of people living in El Salvador had internet access in 2020. In CAR, it is around 10 per cent.

Other African nations have taken to digital payment systems. M-PESA, a mobile phone-based banking system, is used by more than 90 per cent of people in Kenya to store and transfer local currency via SMS. Its success shows it is possible to bank the unbanked in Africa, but via basic systems and existing infrastructure.

If bitcoin is widely adopted in CAR, it will more likely be to line the pockets of criminals and warlords than to boost the economy, says Benedict Manzin at London-based risk-analysis firm Sibylline.

"[Bitcoin] becomes another way for people to get their money out of the country, so it will drive corruption and make abuses by mercenary groups more viable," says Manzin. ▮

Physics

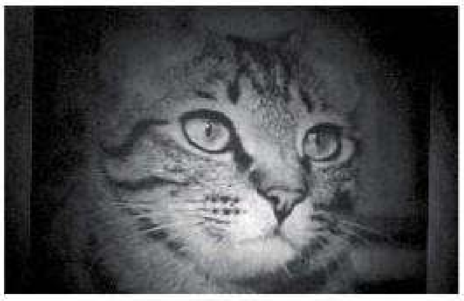
Liquid crystals shape laser beam into a photorealistic cat

RESEARCHERS have encoded a picture of a cat into a laser beam, a method that could be used to more accurately manipulate ultra-cold atoms, which are used to perform simulations of quantum effects.

To trap a cloud of ultra-cold atoms, you have to create what physicists call a potential – essentially a box that holds atoms in place. One way to do this is by creating barriers of light in what is called an optical potential, or optical trap. Sérgio Muniz and Pedro Silva at the University of São Paulo in Brazil have come up with a new way to create optical traps of any shape.

They shine a laser beam through a device called a spatial light modulator made with liquid crystals. These crystals can be organised using electromagnetic fields, creating a series of tiny prisms. By programming the modulator, the team manipulated these prisms to create shapes and patterns in the laser beam (arxiv.org/abs/2204.09724).

"It is very useful to use light to trap these very fragile quantum systems so that you can manipulate them without destroying them," says Muniz. "But if you put ultra-cold atoms in a potential, it has to be very, very smooth and precise." Any imperfections in the optical potential could knock the atoms out of the quantum state you are trying to study. The researchers demonstrated the precision and smoothness of their method by using it to generate a photorealistic image of a cat. Muniz says they figured that because many people encounter pictures of cats or actual cats regularly, any imperfections in the image would be obvious.


P. SILVA & S. MUNIZ

Shining a laser beam into a camera shows the image of a cat embedded in the light

"Honestly, I don't have any good ideas of things you could do with ultra-cold atoms or anything using a picture of a cat, but it's sort of a proxy to show that you can do very fine and precise features," he says. ▮

Leah Crane

Discrimination and harassment

HISPANOLISTIC/ISTOCK

Percentages of respondents reporting workplace discrimination, harassment and bullying based on the following factors

	Gender	Age	Ethnicity	Education	Disability	Sexuality	Other
UK	44%	34%	22%	17%	10%	5%	26%
EUROPE	41%	30%	27%	21%	6%	9%	30%
US	47%	39%	24%	18%	17%	5%	18%

Based on a survey of UK, Europe and US respondents

The workplace can be a hostile environment for minority groups in STEM. Gege Li reports

A safe and secure work environment should be a given. But STEM industries don't always deliver when it comes to discrimination, harassment and bullying, as revealed by this year's New Scientist Jobs Global Employment Report in association with specialist STEM recruitment agency SRG. Despite efforts to tackle these issues and a growing recognition of the importance of a diverse and inclusive workplace, feelings of mistreatment and prejudice may be on the rise in some areas.

Out of more than 4300 respondents working in the STEM industry in the UK, the rest of Europe and the US, it is reassuring to note that those who reported they had faced no discrimination, harassment or bullying in their workplace were in the majority. However, the proportion of those who did report such experiences increased by 7 per cent for women and 4 per cent for men in the UK compared with last year's report.

In all regions, women appear to be bearing the brunt – 32 per cent of women versus 23 per cent of men reported being discriminated against or harassed in their jobs in the UK, with similar figures of 32 per cent versus 21 per cent for the rest of Europe and an even greater disparity of 44 per cent of women versus 28 per cent of men in the US. In terms of the grounds of this discrimination, gender, age and ethnicity emerged as key factors (although in Europe, respondents referring to an unlisted reason, such as religion, outnumbered those stating ethnicity).

Women's experiences of gender-based discrimination were often tied to an assumed lack of professional skills and capabilities, leading to feelings of being undermined or undervalued. One respondent from the UK said it had "been implied that I'm physically inferior and unable to perform as well because I'm female". Some women also said they had experienced sexual harassment or were treated unfairly because they were pregnant or had young children. Meanwhile, some men felt that their organisation's targets for diversity and inclusion – for example, to increase the proportion of women in senior roles – had affected opportunities for promotion or career progression. This may offer some clues about the increase in negative experiences in the face of efforts to the contrary, but other factors are also likely to be at play.

When it came to age, discrimination was again linked to perceptions about ability, and this went both ways. For example, being younger frequently came with a perceived lack of experience and competence, but it may also help with recruitment in some organisations. "In applying for jobs, the recruiting manager always wants the low-cost, younger people with a few years' experience," said one respondent aged between 45 and 54.

The role of "optics"

Ethnicity was another prominent factor for mistreatment, especially for respondents who aren't white. Reported behaviours ranged from microaggressions, such as having their views and contributions dismissed by their colleagues, to more directed actions like sabotage of equipment and being given derogatory nicknames. One respondent also commented that they were presented an opportunity based on the "optics" of them being Asian, but were "never given any trust or responsibility for doing meaningful work".

Given the breadth of negative experiences, do workers feel their employers are adequately addressing these issues? Respondents were asked to what extent they agreed with the following statements: "My workplace has enough measures in place currently to tackle harassment, bullying and discrimination" and "STEM is becoming an increasingly diverse and inclusive industry in which to work". Eighty per cent of those in the UK, 73 per cent in the rest of Europe and 82 per cent in the US either strongly or slightly agreed with the former statement, and roughly 88 per cent on average across all three regions agreed with the latter.

Yet reports of discrimination, harassment and bullying in STEM remain too common and their rise suggests more of the same efforts already under way may not be the solution. With an institutional bias that disproportionately affects women and minority ethnic groups – through their under-representation in academia and senior roles, for example – diversity and inclusion targets alone may not truly level the playing field. Instead, employers can look to successful schemes and programmes that are aimed at promoting diversity and creating opportunities, such as by investing in training and mentoring. It will be fundamental to broaden awareness and understanding of equality, diversity and inclusion in the workplace, while increasing long-term representation and fostering an inclusive culture.

According to its authors, by shedding light on some of the disparities affecting marginalised groups, the SRG Global Employment Report is one step towards better protection and support for STEM employees.

Gege Li is a freelance writer based in London. Download the full salary survey at newscientist.com/globalemploymentreport

Health

What is at risk if Roe v Wade falls?

State laws could restrict abortion in large parts of the US, and other reproductive healthcare offerings may be at stake, reports **Dana G. Smith**

THE US Supreme Court appears to be on the brink of repealing Roe v Wade, the 1973 ruling that protects the right to an abortion in the country. Should the seminal case be overturned, it will be left to each state to decide whether abortion is legal for its residents.

According to the Guttmacher Institute, a reproductive rights research group, 13 states have so-called trigger laws ready that would effectively ban all abortions as soon as the ruling is overturned. Another nine states have restrictive abortion laws enacted before 1973 that will go back into effect if the case is repealed. Four more states are expected to pass anti-abortion legislation as soon as federal protections are lifted.

Six in 10 US women aged 13 to 44 live in one of these 26 states, which are primarily in the South and the Midwest (see "The legal landscape", right). Restrictions in these states would range from abortion bans after six weeks of pregnancy (only two weeks after a first missed period) to recognising "fetal personhood", which declares that life begins at fertilisation and bans all abortions. Some states would allow exceptions in cases of rape, incest or when the pregnant person's life is at risk; others wouldn't.

Several studies have found that abortion rates aren't lower in countries with more restrictive laws, but deaths due to abortion are as much as 34 times higher. These findings have been used to suggest that such restrictive laws don't reduce the total number of abortions, they simply reduce the number of safe abortions.

Antonia Biggs at the University of California, San Francisco, says in the US in 2022, that isn't precisely true. She helped run the Turnaway study, the most comprehensive investigation to date of what happens to people denied an abortion. Biggs and her colleagues interviewed nearly 1000 women across the US, following up with them for five years. They found that, of those who were initially denied an abortion, only about 20 per cent later obtained one.

WIN MCNAMEE/GETTY IMAGES

Activists demonstrating in front of the US Supreme Court on 3 May

"I don't think I agree with this statement that abortions won't go down. We know that they will," says Biggs. Data from Texas, which passed a six-week abortion ban in 2021, supports this. Researchers at the University of Texas at Austin found that the state's abortion rate was cut in half in September 2021, the month the law was implemented, compared with the same month the previous year.

However, thousands of Texans denied an abortion have travelled to a neighbouring state to obtain care in the months since the law was passed. Clinics in Oklahoma, for example, have seen a surge in demand: before the Texas ban, the wait was two or three days for an appointment; after the ban, that went up to four weeks.

"As states drastically limit abortion access – they either ban it entirely or they have earlier gestational bans – you will see this disruption in access from coast to coast because there just are not enough clinics and providers to meet the need," says Elizabeth Nash at the Guttmacher Institute.

23.8

Maternal deaths per 100,000 live births in the US

Travelling hundreds or even thousands of kilometres also isn't feasible for many people, particularly those who have a lower income, need childcare or can't take time off work. In the US, 1 in 4 women will have an abortion, and the majority of them fall into these categories, with 75 per cent being on low incomes and 59 per cent having had at least one prior birth. In fact, the number one reason people seek an abortion is due to financial concerns. So, many experts are concerned that already underserved communities will bear the brunt of a change in US abortion protections.

> "You will see disruption in access from coast to coast because there aren't enough abortion clinics"

"We are definitely going to have individuals, families, communities who are going to be further impoverished, who are going to be further marginalised from the healthcare systems" if Roe v Wade is repealed, says Brandi Shah, a fellow with Physicians for Reproductive Health, a US advocacy organisation.

Will unsafe abortions rise?

People who are no longer able to get an abortion at a clinic might try to manage it on their own. When performed properly, abortion is as safe as common dental procedures. The most recent figures from the Centers for Disease Control and Prevention show that in the US, there are 0.41 deaths per 100,000 legal abortions.

However, when abortions are performed in unsanitary conditions or by untrained providers, they can be deadly. According to a study from 2009, 68,000 women die worldwide from unsafe abortions every year, primarily from haemorrhage and infection. Another 5 million have long-term health implications.

Sarah Prager at the University of Washington says the medications misoprostol and mifepristone

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mean that self-managed abortions are much safer than they used to be. "Pre-Roe, pre-misoprostol, there were clear correlations between legal abortion and safe abortion, and illegal abortion and unsafe abortion," she says. "Those have been decoupled a little bit because mifepristone and misoprostol are so safe."

The US Food and Drug Administration (FDA) approved mifepristone for abortion in 2000. It is now typically combined with misoprostol to end pregnancies in the first trimester. Mifepristone used to only be attainable from a doctor's office, but during the covid-19 pandemic, the FDA made it available via the post and with a telehealth appointment. That was made permanent in December.

However, many states expected to ban abortion would also restrict these medications, and if a person was caught using them, they could be charged with murder. That happened last month in the case of a woman in Texas, though the charges were later dropped.

Even if self-managed abortion is dramatically safer than it used to be, and these medications continue to be used, experts still expect deaths during pregnancy and childbirth to increase if Roe v Wade is overturned. That is because pregnancy can be deadly. The US has the highest maternal mortality rate among high-income nations at 23.8 deaths per 100,000 live births. For Black women, that skyrockets to 55.3 deaths per 100,000 live births – about three times greater than that of white women.

Forcing more people to carry to term will result in a greater number of deaths from pregnancy and childbirth. A study published last year estimated that if abortion were completely banned in the US – meaning it wasn't possible to obtain an abortion in another state or via self-management – the country's maternal mortality rate would increase by 21 per cent. Black people again would be disproportionately affected, with an increase of 33 per cent.

KENT NISHIMURA/LOS ANGELES TIMES VIA GETTY IMAGES

US senators discuss the leaked draft decision to overturn Roe v Wade

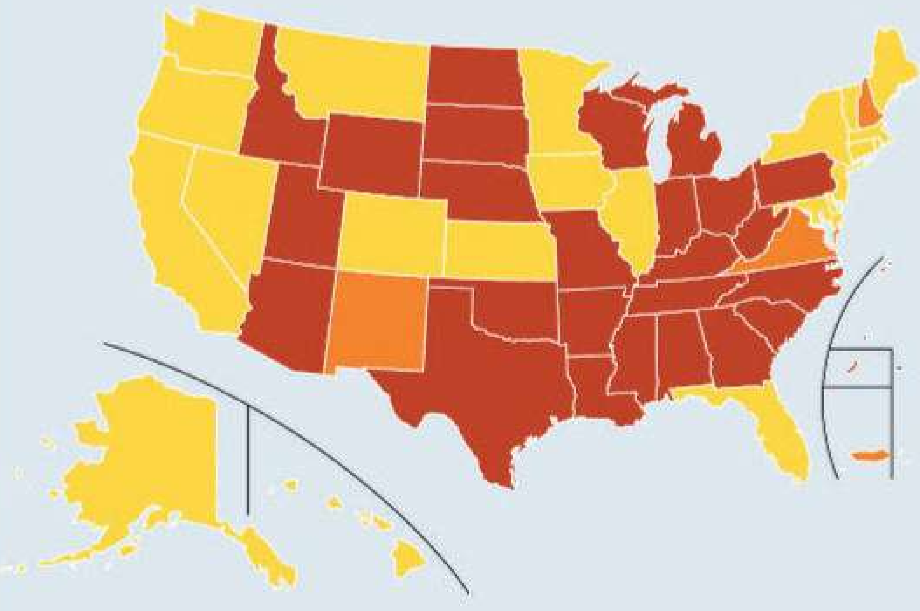
One reason for this disparity is that Black women are over-represented among those seeking abortion, obtaining 28 per cent of abortions in the US while making up 14 per cent of women in the US . The other reason is rooted in systemic racism, says Shah. "Disparities are downstream effects of what we see from a commonly rooted sense of accepted inequity," she says.

Most deaths occur during or shortly after labour, but about 30 per cent occur earlier in pregnancy. In many of these cases, an abortion would save the person's life, but some states would deny people care even then – similar to high-profile cases in Poland and Ireland over the past decade in which people died after being denied an abortion.

Even if an exception is made when the pregnant person's life is at stake, at what point is a condition deemed deadly? "The entire premise is that we have to let people get really, really sick or near death before it is acceptable to intervene, which, of course, is the exact opposite of what we want to do in pregnancy or in health in general," says Prager.

The legal landscape

Abortion rights would be protected in less than half of US states and territories if Roe v Wade is overturned



🟨 **Protected:** Abortion will remain legal in these states, which protect it by law

🟧 **Not protected:** Abortion should still be accessible in these areas, but they do not have laws in place that explicitly protect the right

🟥 **Likely to be banned:** If Roe is overturned, these areas will probably ban or severely restrict access to abortion

SOURCE: REPRODUCTIVERIGHTS.ORG

There are also concerns that other reproductive health services could be restricted. A bill being considered in Louisiana declares life begins at fertilisation. It is unclear how the law would be enforced, but it is conceivable that the definition could apply to embryos created during IVF. As a result, someone could be charged with a crime for destroying excess or abnormal embryos.

"Racial disparities are downstream effects of a commonly rooted sense of accepted inequity"

Some Republican law-makers have also declared some forms of birth control, such as intrauterine devices and the morning after pill, to be abortion-inducing substances, even though they aren't. These primarily work by stopping ovulation or fertilisation, but they may also prevent implantation of an embryo in the lining of the uterus, which would be deemed homicide under the proposed Louisiana law.

These consequences are still hypothetical, but the Turnaway study shows that people denied abortion are more likely to have poor physical and mental health, live in poverty and stay with an abusive partner. What's more, some studies have shown that children born from an unwanted pregnancy and a family's other children are less likely to bond with the mother and achieve developmental milestones. ▮

Technology

I'm in a virtual world – leave me a message

Alex Wilkins

A VIRTUAL reality "answering machine" can record changes in a person's immediate environment while they are immersed in virtual worlds and play them back later.

In workplaces of the future, people may have to focus on tasks in virtual environments, making them unavailable for real-time communication with colleagues.

"The challenge is: can we create a reality where we can still talk naturally even though the other person might, at that very moment, not be available?" says Andreas Fender at ETH Zurich in Switzerland.

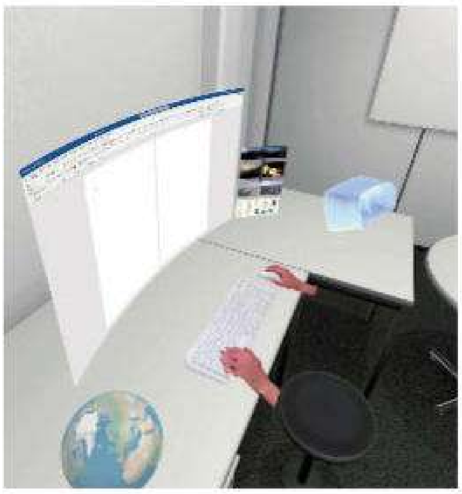
He and Christian Holz, also at ETH Zurich, developed a system called AsyncReality that records events in the real world and replays them virtually at a later point.

It uses four depth-perceiving cameras that can tell how far away an object is and reconstruct the room in 3D. While the worker is in "focus mode", the system records changes in the environment and detects events that are causally related to each other, so they can be played back in a sequence later.

Fender and Holz presented the work at the Conference on Human Factors in Computing Systems in New Orleans, Louisiana, on 2 May.

"The whole office arrangement in the future might be completely different"

In one scenario, a colleague enters an office worker's room while he is working in a VR environment, so she leaves an object on his table and records a message. When the worker finishes his virtual task, he can see and pick up the object in virtual space, replay how it got there and watch the message left for him.



ETH ZURICH

A virtual reconstruction of an office worker's surroundings

Fender says this is a basic example, but the system can assist with more complex scenarios. "The whole [office] arrangement in the future might be completely different because it's intertwined with the virtual world which we interact with at the same time," he says. It could also be useful when someone isn't in the office at all, but working remotely, he says.

"The overall system is really interesting because it's a logical extension of record-and-replay-it answering systems," says Anthony Steed at University College London.

Apart from replaying missed visits from colleagues, AsyncReality could recreate other events, such as a group whiteboard session, says Steed. "You can see not only what's there when you come back in, but perhaps how it got constructed – it may support hybrid working," he says.

It could also be useful for people working on complex, choreographed procedures, such as in medicine or manufacturing, so they can replay what happens when they have to step out of the room, says Steed. But the need to constantly record work environments might lead to privacy concerns, he adds.

Wildlife

Jackals seen stealing prey killed by lynx

Joshua Rapp Learn

WATCH out cats – there's a new dog in town. Golden jackals (*Canis aureus*) are expanding their range in Europe and the acquisition of new territory may come at the expense of the Eurasian lynx (*Lynx lynx*).

According to new research, jackals have been seen scavenging carcasses of deer killed by lynx in southern Slovenia. While the evidence is limited at this point, it shows the first recorded incidents of kleptoparasitism – the act of stealing food – against lynx in Europe by jackals.

"There are a lot of concerns about what impact jackals will have ecologically because they are a new species [in parts of Europe] and they are spreading fast," says Miha Krofel at the University of Ljubljana in Slovenia, who led the research.

Historically, golden jackals were found mostly in the Middle East and south Asia. In the 20th century, they began expanding northwards, reaching Slovenia by 1955. Today, they can be found as far north as Norway.

Wildlife researchers have long wondered how this expansion may affect other carnivores, but had scant evidence of direct interactions. Krofel and his colleagues had been conducting a long-term study from 2006 to 2021 on lynx in the Dinaric mountains in Slovenia when they found evidence of jackals stealing prey.

Two different incidents captured on camera show at least two jackals eating deer killed recently by lynx in the more recent years of this study. In both cases, the research revealed that the lynx didn't return to the kill site after the jackals arrived. It is unclear whether the lynx were scared away from their meal (*Global Ecology and Conservation*, doi.org/htcp).

So far, jackals have colonised about 13 per cent of the lynx's range in Europe, but this is up from a 2 per cent overlap a decade ago. If jackals were to increase in number and steal food often from lynx, it could add another pressure for these populations. "This is the first very concrete case of what jackals in the new ecosystem might represent," says Krofel.

A golden jackal captured by a camera trap in Slovenia

MIHA KROFEL

THE WORLD IS EVOLVING.

WE ARE TOO...

Animal behaviour

Hungry worms will risk hurt if it helps them reach a meal

Corryn Wetzel

HUNGRY worms are more willing than satiated worms to cross a toxic barrier of copper to reach the scent of a meal.

To better understand how hunger changes behaviour, Sreekanth Chalasani at the Salk Institute in California and his colleagues turned to transparent roundworms called nematodes. They aimed to answer three key questions: how does hunger affect what is happening in the worm's body, how is that change relayed to the brain and how does that ultimately shape choices?

The team placed about 60 nematodes (*Caenorhabditis elegans*) on one side of a barrier made of copper, which is toxic to them, with the smell of buttered popcorn wafting over from the other side. Half of the worms hadn't eaten for 3 hours, while the others had eaten a recent meal.

The team found that some 80 per cent of the hungry worms crossed the copper to reach the food compared with around 20 per cent of their well-fed counterparts. When the hungry worms were fed, they reverted to the less-risky behaviour of satiated worms.

Nematodes take more risks when they are hungry

STEVE GSCHMEISSNER/SCIENCE PHOTO LIBRARY

Using genetic and imaging analysis, the team showed that certain proteins in the worms' intestinal cells may tell the brain that the gut needs food (*PLoS Genetics*, doi.org/hs3n).

"The intestine tells the brain, and the brain then changes behaviour," says Chalasani. "We didn't expect that the worm would have this level of sophistication." ▮

Psychology

Privileged people misjudge pro-equality policies

Carissa Wong

PENCER PLATT/GETTY IMAGES

People receiving food donations at a mosque in New York

PEOPLE from privileged groups may misperceive equality-boosting policies as harmful to them, even if they would actually benefit.

Previous studies have found that advantaged people often don't support interventions that redistribute their resources to others who are disadvantaged, in zero-sum scenarios where there are limited resources.

Now, researchers have explored the degree to which people from privileged groups think equality-promoting policies would harm their access to resources in scenarios where the strategies would benefit or have no effect on their group, while bolstering the resources of a disadvantaged group.

Derek Brown at the University of California, Berkeley, conducted a series of studies involving a total of more than 4000 volunteers in the US.

In one study, they presented white people who weren't Hispanic with policies that didn't affect their own privileged group and benefited a disadvantaged group that they didn't belong to: people with disabilities, those who had committed a crime in the past, members of a racial minority group or women. Importantly, the researchers told participants that the resources – in the form of jobs or money – were unlimited.

For example, one policy would direct more money to mortgage loans for Latino homebuyers without limiting how many mortgage loans were available for white people.

> **"It's pretty troubling what we found, but I think there is a way forward – we just have to find it"**

Participants were then asked to rank how they thought the policy would affect the privileged group's access to resources on a scale from greatly harmful to greatly beneficial. The team found that, on average, advantaged people perceived equality-boosting policies as harmful to their resource access, even though they were told that resources were boundless.

"We find that advantaged members misperceived these policies as a sacrifice to their group, even when that's not the case," says Brown.

The researchers then asked participants to consider a win-win scenario involving equality-promoting policies that benefited both the disadvantaged and privileged groups – but the latter to a lesser extent. In this case, most privileged people thought equality-enhancing policies with benefits for all would be more harmful to them than inequality-enhancing polices that came at a cost to both groups (*Science Advances*, doi.org/htcg).

"We thought, maybe if we make a win-win or mutual-benefit situation, then maybe [advantaged people] will see the equality-enhancing policies as helpful. But they didn't," says Brown.

"It was an ambitious series of studies that did an excellent job of ruling out alternative explanations," says Dan Meegan at the University of Guelph, Canada. "The work paints a pretty dark picture for those trying to convince people to support policies designed to reduce intergroup inequality."

However, Brown thinks education could help to tackle inequalities by making people more aware of this tendency to misperceive equality-boosting policies that would actually benefit them.

"It's pretty troubling what we found. [But] I think people have the capacity to believe in these policies. And I think there's a way forward – we just have to find it," he says. ▮

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Environment

Toxic foam clouds hit Colombia

Polluted rivers near Bogotá are creating dangerous froth that is making people sick

Luke Taylor

AS DOWNPOURS intensified on 23 April on the outskirts of Bogotá, Colombia, toxic foam from an adjacent river started engulfing the Los Puentes neighbourhood.

Fluffy white froth emerged from the water and reached a height of 5 metres, blanketing cars and roads, says restaurant manager María Morales. Eventually, it crept in the windows of her kitchen, forcing her to close the business.

"If it were normal foam, the kids would love it," says Maria Chacue, who has a hard time stopping her 22-month-old son from playing in the toxic chemicals. "But it's not normal. It's so polluted."

Environmental officials blame heavy rains driven by the La Niña weather phenomenon, which have caused widespread flooding in Colombia in recent weeks. As the Bojacá and Subachoque rivers converge near Los Puentes, they churn up contaminants.

Tests show that the responsible chemicals are largely cleaning products, says Edwin Garcia, a government official overseeing environmental controls in the region. But a wide range of pollutants are present. Oils from cooking and fertilisers from crops eventually find their way into the rivers, too, says Sergio Valero, director of risk management for the region. Rubbish and dead animals are dumped in the rivers, and though dumping waste is illegal, some businesses discard toxic materials at night, he says.

A new waste-water treatment plant was installed in the small municipality in 2020 and the local council is educating people on proper waste disposal.

A woman runs from toxic foam at her house in Mosquera, Colombia

REUTERS/LUISA GONZALEZ

Residents say the amount of toxic foam is the highest it has ever been, but it isn't new. They are used to a pungent sulphuric smell that crops up whenever it rains.

Colombia's poor waste-water treatment is killing its rivers, says Luis Camacho at the University of The Andes in Bogotá. He says 60 to 70 per cent of domestic waste water goes straight into natural waterways untreated. Surfactants, such as soaps, shampoo and detergents, become toxic organic compounds if not treated, he says.

Camacho believes that the high rates of diarrhoea seen near Colombia's main rivers are due to viruses and bacteria in untreated water. Chacue's son has a cold, which residents say is a common occurrence – along with other illnesses such as diarrhoea – when it rains. She and others venture outside with hoodies and face masks to avoid getting an itchy, red rash from the foam.

Phosphates in Colombian detergents exacerbate the problem. These make cleaning products more effective, but are banned in much of Europe and the US because they are hard to break down through natural processes and can over-enrich plant life, causing toxic algal blooms.

In Los Puentes, phosphates have accelerated the aggressive growth of aquatic plants, such as water hyacinths, which trap pollutants. The council for the surrounding municipality of Mosquera cleared the water hyacinths to help the river flow better, but it still contains the pollutants. ▮

Health

Brain cells linked to Parkinson's disease finally identified

THE subtype of brain cells that die in Parkinson's disease has been discovered using a new technique that can identify which genes are active in individual cells.

We have known for decades that Parkinson's disease, a progressive condition that results in the development of tremors and difficulties in moving, is linked with the gradual death of cells in part of the brain called the substantia nigra. The cells concerned make a signalling chemical called dopamine, involved in controlling movement – but their exact identity was unclear.

Evan Macosko at the Broad Institute of MIT and Harvard and his colleagues looked at cells from the substantia nigra of eight people who didn't have Parkinson's and had agreed to donate their brains for research after death.

The researchers used a relatively new technique called single cell RNA sequencing, which allows cells within a tissue to be analysed individually to see which of their genes are active and producing proteins. They found that there were 10 different subtypes of dopamine-producing cells within the substantia nigra.

Next, the researchers used the same technique to examine the brains of 10 people who had died with either Parkinson's or a similar condition called Lewy body dementia. They found that only one of the subtypes of brain cells was reduced in number, suggesting many cells of this subtype had died while the people were alive (*Nature Neuroscience*, doi.org/hs3k).

"The findings should lead to a better understanding of Parkinson's and a way to assess treatments"

There are about 100,000 of these cells in a healthy adult brain. "It's a very small subset," says Macosko. "It was like looking for a needle in a haystack."

The findings should lead to a better understanding of the causes of Parkinson's and a way to assess potential treatments, he says. If the cells are grown in a dish, new medicines could be tested on them, for instance. ▮

Clare Wilson

Wildlife

Vaquitas could breed their way back from brink of extinction

Corryn Wetzel

THERE are only 10 vaquitas left in the world, but a genetic analysis suggests the small porpoises aren't necessarily doomed to extinction – so long as they stop getting ensnared in fishing nets.

Marine biologists estimate that even at their most populous, vaquitas (*Phocoena sinus*) never numbered more than a few thousand individuals in the Gulf of Mexico.

By the 1990s, there were just hundreds left. Vaquitas' naturally small population size reduced their genetic diversity, which researchers worried could lead to offspring that are less healthy than their parents. "But our study is showing that reality is more nuanced than that," says Jacqueline Robinson at the University of California, San Francisco.

Robinson and her colleagues analysed 20 vaquita genomes, which came mostly from animals that died between 1985 and 2017.

They used the genetic data to model the species' future. When vaquita by-catch deaths were reduced by 80 per cent, the species went extinct in more than half of the simulations, they found. But when such deaths were halted, the species recovered in more than 90 per cent of the simulations (*Science*, doi.org/gp32s3).

"I was pleasantly surprised," says Robinson. "I didn't expect [the results] to be that optimistic."

The vaquita lives near the northern end of the Gulf of Mexico

PAULA OLSON/NOAA

Neuroscience

Webcam test could show whether you lack a mind's eye

Jason Arunn Murugesu

JASPER JAMES/GETTY IMAGES

Some people are unable to visualise objects in their head

AS MANY as 3.9 per cent of people have aphantasia, the inability to picture images in their head. But formally diagnosing the condition is difficult. A simple physiological test involving a webcam could one day offer a solution.

We have known since the 19th century that some people lack a mind's eye, but interest in the phenomenon grew only about 10 years ago.

Now, Rebecca Keogh at Macquarie University in Australia and her colleagues have studied the effectiveness of a test they have developed for aphantasia by recruiting 56 people without the condition and 18 people who said they have it.

The test is based on changes to pupil size. Looking at a bright object causes a person's pupils to constrict in order to reduce the amount of light hitting the retina. Dim objects, on the other hand, cause the pupils to dilate to boost the amount of light reaching the retina. The researchers speculated that a similar effect could be observed if people were told to imagine a bright or dark object.

"My favourite theory is that when you imagine a mental image, you recruit brain areas involved in perception… and these areas are connected to parts of the brain that are controlling the size of the pupil," says Thomas Andrillon at the Paris Brain Institute, who worked on the study.

> "It is a promising step to have a more objective way to measure visual imagery ability"

In their tests, the researchers tracked each person's pupil size using an infrared camera. They showed a participant a bright image of an object on a screen for 5 seconds, and told them to memorise it. After the image disappeared and the participant's pupils had returned to their original size, they were asked to imagine the object in their heads. This task was repeated until they had looked at 16 bright images and 16 dark images.

The pupils of all participants changed in response to seeing bright and dark images on the screen. About 90 per cent of those without aphantasia also showed pupil size changes when told to imagine those images. However, the same was true of just 39 per cent of people who said they had aphantasia (*eLife*, doi.org/hsxm).

Andrillon suggests the test could one day be used to check if someone has aphantasia. The current method, called the binocular rivalry task, requires mirrors and can't easily be carried out at home, he says.

But Keogh says the test still needs to be refined before it can be used widely. "We cannot run this study without access to infrared glasses that can measure pupil size," she says.

This is because the pupil size changes seen in those without aphantasia are still very small – a change in diameter of about 0.2 to 0.4 millimetres.

The team wants to gather more data with larger sample sizes and hopes to develop a test that can be done at home via a laptop webcam.

Andrillon says such a test would be important because many people only discover they have aphantasia later in life. "We're not always necessarily experiencing things the same way other people are experiencing things," he says.

"It is a promising step for the field to have a more objective way to measure visual imagery ability, especially for researchers who are interested in visual imagery extremes like aphantasia," says Zoë Pounder at the University of Oxford. However, she says the study needs to be replicated with larger sample sizes.

Extreme weather

LANCE KING/GETTY IMAGES

Five recent mega heatwaves that slipped under the radar

THE worst heatwaves recorded have now been identified, including five that were more severe than the deadly western North American heatwave last year.

"We started by looking at the heatwave last June in the US and Canada, which... everyone was quite shocked by. Then we found five events that were more extreme than that," says Vikki Thompson at the University of Bristol, UK. These were in southern Brazil in 1985, South-East Asia in 1998, south-west Peru in 2016, south-east US in 1980 and Alaska in 2019.

"Many of these events are in parts of the world where they were missed because they had less impact on us in the Western world, or where there are less people and they're just not monitored so well," says Thompson. She and her team started by analysing historical temperature data from 158 regions of the world from 1968 to 2021.

They used a climate model to fill in gaps in measurements, before pinpointing daily temperatures in each region that were so high there was less than a 0.1 per cent chance of them occurring normally. Many regions – including most of Africa – weren't included due to a lack of reliable data, says Thompson.

The team also predicted how common heatwaves would be in North America under various global warming scenarios. In a worst-case scenario, with a 4.3°C increase in average global temperature by the end of the century, it estimated a 1-in-6 chance of an extreme heatwave occurring each year by the 2090s (*Science Advances*, doi.org/hs29). **Carissa Wong**

Health

Jab for glandular fever virus tested

A VACCINE that wards off the common Epstein-Barr virus to potentially prevent glandular fever, multiple sclerosis (MS) and even some cancers has shown promise in mice, ferrets and monkeys. A human trial is expected to start in 2023.

Gary Nabel at ModeX Therapeutics in Natick, Massachusetts, and his team developed a vaccine that exposes the body to two proteins that Epstein-Barr virus uses to invade cells, training the immune system to recognise the pathogen. Initial tests showed that mice, ferrets and rhesus macaques developed antibodies against Epstein-Barr virus post-vaccination.

To better understand the jab's potential in people, the researchers engineered mice with human-like immune systems. When exposed to Epstein-Barr virus, only 17 per cent of the mice became infected after receiving antibodies from other vaccinated rodents. In contrast, 100 per cent of the mice without antibodies became infected (*Science Translational Medicine*, doi.org/gp3x6n).

None of the mice given vaccine-induced antibodies developed lymphomas – cancers of the lymphatic system that are increasingly being linked to Epstein-Barr virus – but half of the unprotected rodents did. The team didn't look into other Epstein-Barr-related conditions, such as stomach cancer.

More than 95 per cent of adults worldwide are infected with Epstein-Barr virus, a type of herpes that most commonly spreads via saliva. It is known to cause glandular fever, also called "mono", and is associated with MS.

If the vaccine is shown to be safe and effective in people, it could be given to children to prevent Epstein-Barr-related conditions, says Nabel. **Alice Klein**

Diet

Eat microbial protein to spare the forests

SWAPPING a fifth of the world's meat consumption for eating meat-free microbial protein made in factories would more than halve global deforestation and related carbon emissions.

Cattle ranches and crops grown to feed cows are two of the biggest drivers of trees being cleared across the tropics, which is continuing despite political pledges to curb the loss of carbon-rich, biodiverse habitats.

SIMON DAWSON/BLOOMBERG VIA GETTY IMAGES

Microbial proteins, such as the Quorn mycoprotein made from a fungus and sugar in heated vessels, have already been shown to have a lower environmental impact than meat from ruminants such as cows and sheep. But their future potential – as populations grow, food demand rises and diets shift – hasn't been fully explored.

So Florian Humpenöder at the Potsdam Institute for Climate Impact Research in Germany and his colleagues modelled what would happen in various scenarios, including 20 per cent of ruminant meat consumption per person being substituted for microbial proteins by 2050.

They found that this scenario would cut deforestation greatly, from 8.4 million hectares annually compared with business as usual, to 3.7 million hectares. Net carbon dioxide emissions would fall from 5.5 billion tonnes in 2050 to 2.4 billion (*Nature*, doi.org/hs3j). **Adam Vaughan**

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Really brief

SHUTTERSTOCK/MARTIN PELANEK

Acrobatic birds evolved to be small

Male birds that impress females with complex acrobatics – such as the blue-crowned manakin (pictured) – tend to be smaller than females of the same species. This may be because smaller males find it easier to perform agile aerial manoeuvres (*Proceedings of the Royal Society B*, doi.org/hsxr).

Trees beat energy crops as CO_2 sink

Nearly twice as much carbon could be removed from the atmosphere by using available land in the US to plant forests rather than grow fuel crops and capture the carbon dioxide emitted when those crops are burned, says a study. Trees can also help to avert water shortages (*Science Advances*, doi.org/hsxs).

Insect decline seen in UK bug splat data

Between 2004 and 2021, there was a 58.5 per cent fall in the number of insects splatting on UK cars for each mile driven, according to a citizen science survey organised by the charity Buglife. The decline is the latest evidence that insects are struggling, probably in part because of the intense use of insecticides.

Glaciology

Vast water store under Antarctic ice

ANTARCTICA is hiding a lot of water under its surface. It has long been thought that there might be groundwater buried beneath the ice, but until now there has been no conclusive evidence of this.

Within Antarctica's ice sheet, corridors of relatively fast-moving ice called ice streams flow to the ocean. Researchers already knew that shallow pools of water – typically millimetres to a few metres deep – can sit between the ice streams and the ground below.

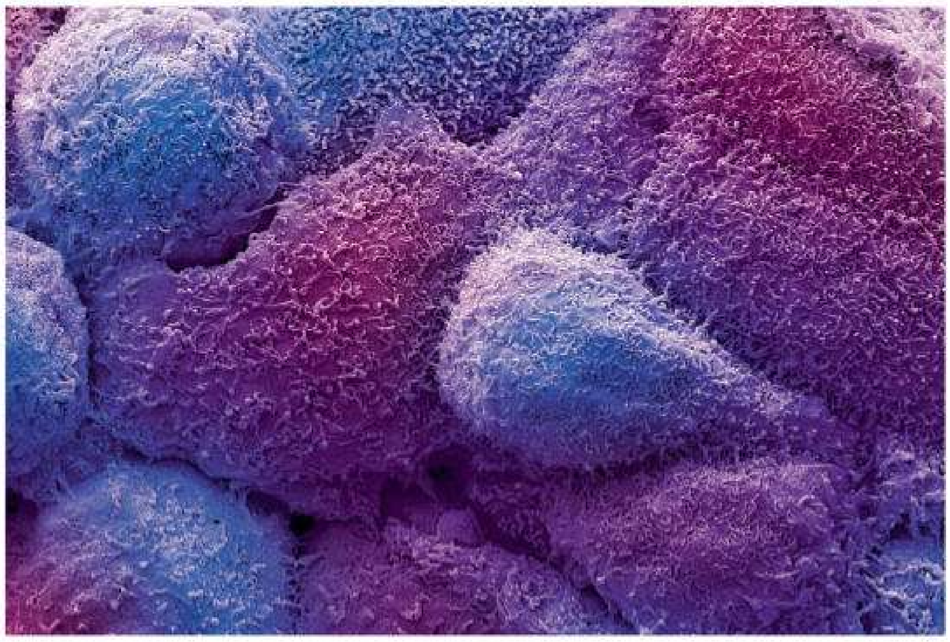
Chloe Gustafson at the University of California, San Diego, and her team wanted to see whether there was a larger reservoir of moving water beneath the Whillans ice stream in West Antarctica. By measuring seismic activity and electromagnetic fields, they found a kilometre-thick layer of sediments saturated with a mix of fresh glacier water and ancient seawater.

It contains more than 10 times as much water as the shallower pools beneath the ice stream, and water seems to flow between the deep and shallow areas (*Science*, doi.org/gp32s2).

The apparent connection suggests the groundwater may be important for controlling the flow rate of the ice streams, a process that is crucial to understand for predicting the effects of climate change on sea level.

"Antarctica as a whole, the whole ice sheet, contains [enough water to lead to] about 57 metres' worth of sea level rise," says Gustafson. "Ultimately, we want to understand how quickly that ice is going to flow off the continent… and affect sea level." **Leah Crane**

Human evolution



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Gene change after split from chimps linked to cancer risk

A TINY change in our DNA that occurred after we evolved away from other primates has made us more prone to getting cancer, new research suggests.

Cancer is relatively rare in other primates. For example, autopsies of 971 non-human primates that died at Philadelphia Zoo in Pennsylvania between 1901 and 1932 found that only eight had tumours.

To learn more, Christine Iacobuzio-Donahue at Memorial Sloan Kettering Cancer Center in New York and her team compared hundreds of genes in humans and 12 non-human primate species.

They discovered that we have evolved a slightly different version of a gene called *BRCA2* since we split from chimpanzees. *BRCA2* is known as a tumour suppressor gene because it is involved in DNA repair.

The team found that a single DNA letter change in human *BRCA2* made it 20 per cent worse at fixing DNA than other primate versions (*Cell Reports*, doi.org/hs3d).

We already know something about the role of *BRCA2* in human cancer. For example, people with certain variants that suppress its repair activities further have even greater risk of developing cancerous tissue, particularly breast (pictured) and ovarian cancers. AK

Space

Turning moon dust into oxygen and fuel

LUNAR soil could be used to make oxygen and other products from chemical reactions that mimic photosynthesis, according to an analysis of samples returned by the Chang'e 5 rover. Reliable supplies of such substances are necessary for a future lunar base.

Yingfang Yao at Nanjing University, China, and his colleagues examined a lunar soil sample to see if it could be used as a catalyst to convert carbon dioxide and water released by astronauts' bodies into oxygen, hydrogen and other useful by-products like methane that could be used to power a lunar base.

Yao and his team first analysed their sample using techniques such as electron microscopy to identify catalytically active components of the soil and found high levels of iron and magnesium compounds that could be useful.

They then tested the soil as a catalyst in various reactions that would form part of a process to produce hydrogen and oxygen from CO_2 and water. They found it worked, but that the efficiency wasn't as good as catalysts we have on Earth. However, tweaks to the structure and composition of the soil might improve things (*Joule*, doi.org/gp3zq7). **Alex Wilkins**

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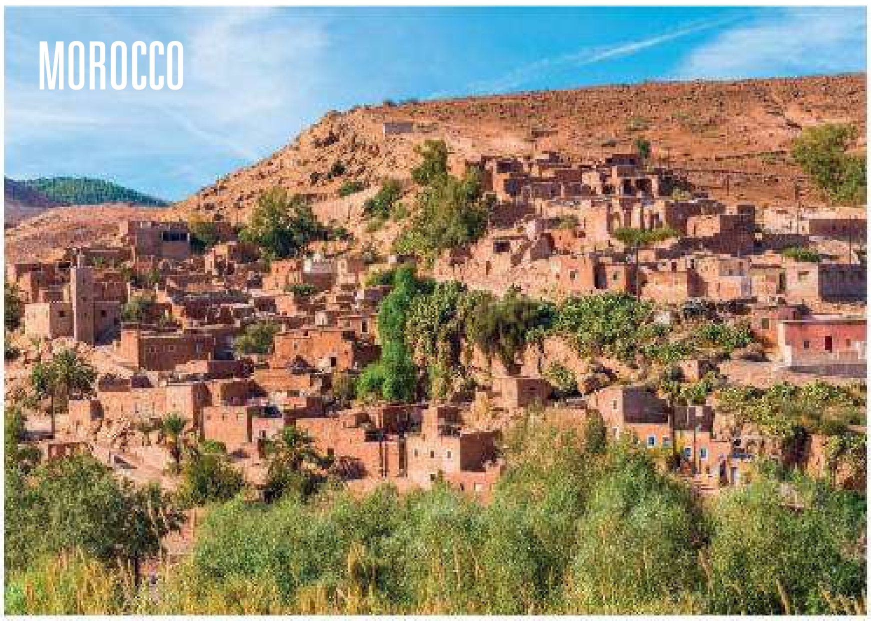

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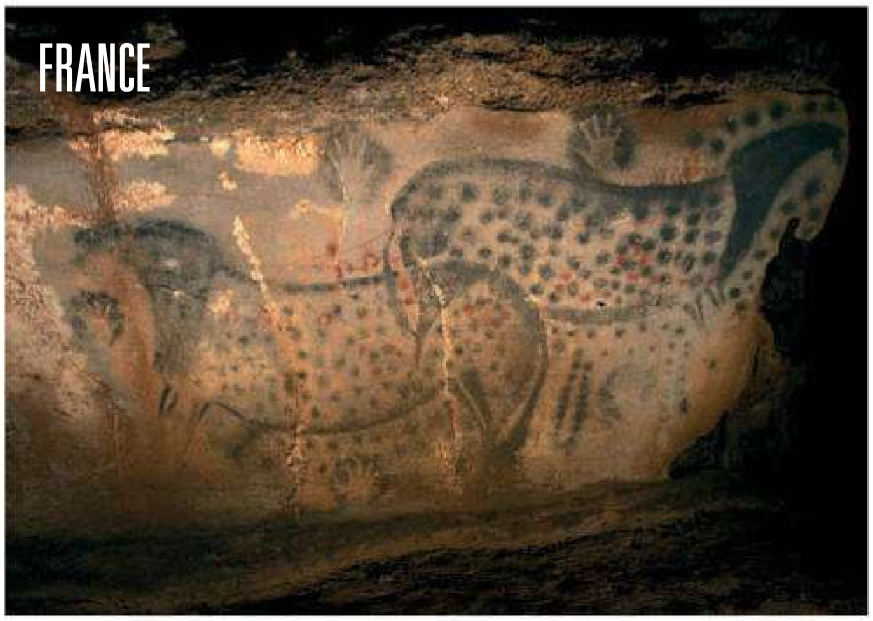

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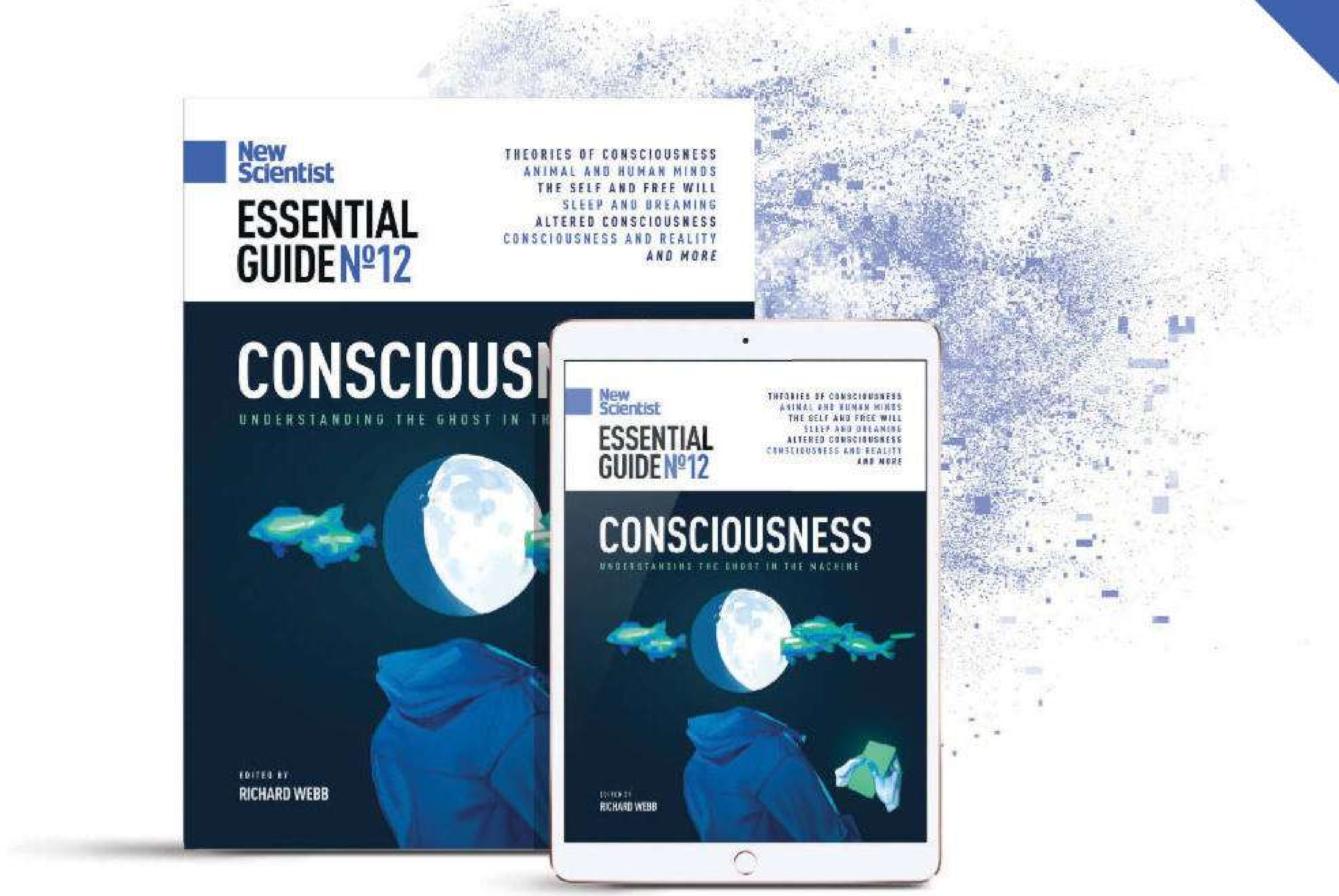

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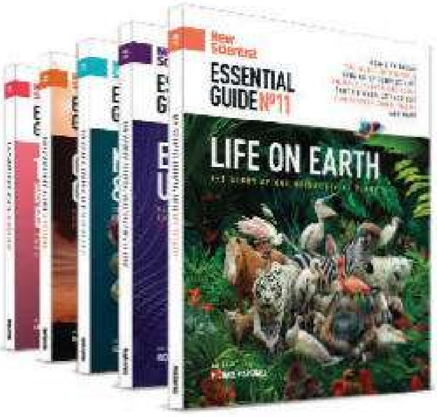

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Comment

Not alien, just Australian

Writing off the amazing adaptations of Australian mammals as "weird" and "primitive" hurts conservation efforts, says **Jack Ashby**

MICHELLE D'URBANO

HOW would you describe Australian mammals? My work involves regularly talking to people about them. When I say that platypuses' duck-like bills can detect the electrical impulses controlling the heartbeats of their prey, or that males have venomous ankle spurs, or that their hands are like Swiss Army Knives, with different foldaway tools for swimming, digging and walking, the typical response is a wide-eyed, "That's so strange!".

Not all mammals are considered equals. Why is it that the ingrained response to the incredible adaptations of Australian mammals is to call them "weird"? "Primitive" is often thrown into the mix too, even though all living complex species are equally evolved. The fauna of no other large land mass is treated this way.

We have been conditioned to repeat such views because they are the typical messages featured by museums and documentaries. The BBC's 2019 series *Seven Worlds, One Planet* included this line in its description of the episode on Australia: "Isolated for millions of years, the weird and wonderful animals marooned here are like nowhere else on Earth." However conservation-focused the production was, the framing of Australian wildlife as weird is unhelpful.

Thankfully, platypuses, koalas, kangaroos, wombats and their relatives are popular. People are enthusiastic about these creatures because they are interesting, but we need to avoid making subtle value judgements.

These pejorative trends can be traced back to early colonial accounts of Australia, which are peppered with unscientific slurs. When Europeans first saw Australian marsupials and egg-laying mammals, they were so unlike anything they had seen before that it required them to rethink their understanding of the tree of life. Crucially, in perceiving Australian animals to be different to those they were familiar with in the "Old World", European colonists assumed that they were inherently inferior.

This notion of inferiority was tied up with how the colonial machine sought to paint the whole country as subordinate to the northern hemisphere. The animals continue to carry this baggage today, which has major ecological implications as it risks devaluing and othering Australian wildlife.

This is important because, despite great public affection for its platypuses, echidnas and marsupials, Australia has the world's worst extinction record for mammals today. Over a third of all the world's recent mammal extinctions have occurred there, from famous thylacines to less well-known broad-faced potoroos and desert bandicoots.

Surviving species are also in crisis. Fossil evidence shows that northern hairy-nosed wombats were once widely distributed over eastern Australia, but today they are found only in Queensland, numbering about 300 individuals. Stripy, squirrel-sized numbats were previously found across most of southern Australia, until they were restricted to a tiny pocket of the country's south-west.

There are many human-induced drivers for extinction in Australia, including introduced species and altered fire regimes, but a key issue is that conservation isn't a government priority. There is no legal requirement for the government to protect its long list of threatened species, and support is therefore weak. One report found that the government is failing to monitor threats, failing to effectively develop species recovery plans and – when it does – failing to check if they work.

We protect what we value, and if these incredible, highly adapted species are incorrectly written off as biologically inferior weirdos – cute, but ultimately evolutionarily doomed to fail – it makes conserving them much harder. ▮

Jack Ashby is assistant director at the University Museum of Zoology in Cambridge, UK, and author of *Platypus Matters*

Field notes from space-time

Science: a team sport

Far from the stereotype of a lone genius, research is very collaborative. We must get better at showing others what it is really like, says **Chanda Prescod-Weinstein**

Chanda Prescod-Weinstein is an assistant professor of physics and astronomy, and a core faculty member in women's studies at the University of New Hampshire. Her research in theoretical physics focuses on cosmology, neutron stars and particles beyond the standard model

I AM a person who likes things to be specific and accurate. In some ways, this is antithetical to being a communicator of science to general audiences. This requires helping non-experts understand complex ideas – like the idea of quantum fields – while deploying only a small fraction of the language we professionals use to talk among ourselves. It means glossing over details that can feel fundamentally important. Which is to say that I regularly have to grapple with what it means to talk to people about something when I know I'm not going to give them the full story.

I find it easier to be successful in writing. Here, I can choose my words carefully, and the "optics" of the work I am trying to get across are what I manage to evoke in the reader's mind.

By contrast, one of my biggest frustrations is with how science is portrayed on television. There, it seems like a production mandate to have flashy graphics and representations of "what scientists do" that align with public expectations. The result? We get a lot of representation of people (often white men) in white lab coats, even though many (perhaps most?) scientists don't wear a lab coat of any kind, ever.

For theoretical physicists, the expectation is that we will have a chalkboard filled with equations. For some people that is accurate, but I dislike the feel of chalk on my fingers. I much prefer writing with a fountain or gel pen in a high-quality, bound notebook.

Part of what ends up being so off in popularisations of science is that we continue to get various versions of the lone genius: someone sitting at their desk or working at a chalkboard alone, thinking important thoughts.

The reality is that – as an introvert – I wish I got more time alone. My days are filled with meetings. Every single member of my dark matter and neutron star research group has at least one per week with me that is centred on their main research question. There is a member of my team who sees me in a meeting between two and five times a week. One of those is my group meeting, where everyone comes together and shares what they have accomplished since the previous week. They take turns asking each other questions. This allows us all to learn more and hone our question-asking skills, which is important for scientists.

> "We get a lot of representation of white men in lab coats on TV, though many scientists don't ever wear one"

I have other regular appointments that might seem peripheral and even boring – including to the participants – but that are quite important to the doing of science. These are the conversations in which we are planning for the future, navigating applying for grant money or lobbying for more grant money to be allocated so that our discipline is sustained in the future. Right now, I am spending a lot of time on the delayed Snowmass 2021 Particle Physics Community Planning Process.

This occurs about once a decade, and involves the US particle physics community getting together to determine what science in this field is plausible in the coming years and what experiments – maybe a new particle collider, maybe a new telescope focused on dark matter – should be built. The lengthy report we produce will be read by a government-appointed group that will determine what can be funded for the next decade or so. Participating in this process is time-consuming and doesn't immediately advance my research, but it is also a key part of my job.

Ultimately, science is a collaborative enterprise, perhaps more so than any other area of academic endeavour. We depend on others to get our work done and interact a lot with other people, but, again, I don't think this is well represented on television.

Instead, we get stereotypes of weirdos who can't handle social interactions, when in fact we are a collection of weirdos who navigate social interactions just fine because our jobs depend on it.

Our work is also often messy. I don't just mean that we argue, though we do. It is also the case that we often don't think in pretty pictures. I wish we could show the public more often what our work actually looks like, so that we could help people understand what we actually do. At a time when anti-intellectualism passes for a mainstream political position, now more than ever, we need the public to be tuned into how our enterprise actually works.

Plus, in my corner of science, hoodies are a more standard uniform than lab coats. Shifting stereotypes about how scientists look could help younger people see themselves in us, to realise that we are everyday people, just like them. I understand the desire to dress things up for a bit of Hollywood drama, but I don't think we have to try so hard to make science seem exciting. What matters is making sure we are able to explain why it is exciting. That is the hard part, and I won't always succeed, but I do enjoy trying. ■

Chanda's week

What I'm reading

I finished Sara Nović's novel True Biz *in one sitting, and learned a lot of deaf history, including why American Sign Language is so different from the British version.*

What I'm watching

Baseball season is back, and I bleed Dodger blue.

What I'm working on

Wrapping up a paper with colleagues on the unique structures made by a hypothetical dark matter particle, the axion.

This column appears monthly. Up next week: Graham Lawton

Welcome to our Signal Boost project – a page for charitable organisations to get their message out to a global audience, free of charge. Today, a message from **Milton's Cottage**

A museum that's out of this world

WHY SCIENTISTS SHOULD READ MILTON (AND VISIT MILTON'S COTTAGE)

As his only surviving residence, it may seem counter-intuitive to *New Scientist* regulars to read about the place where Milton completed his religious epic *Paradise Lost*.

But from the 17th century to the present-day, major scientists have been inspired by Milton's work. Florence Nightingale revered him, Darwin carried a copy of *Paradise Lost* on board the Beagle, and Nobel Prize winning geneticist Sir Paul Nurse gives lectures on this visionary writer.

NEW SCIENTISTS OF THE 17TH CENTURY

Milton himself kept up with the new science of the 17th century and even met Galileo, by then under house arrest. This meeting made quite an impact: the great Italian astronomer is his only contemporary mentioned by Milton in *Paradise Lost*.

THE FIRST WORK OF SCIENCE FICTION?

Perhaps because of this encounter, Milton's poetry abounds in scientific references - and in *Paradise Lost* he wrote what is arguably the first work of science fiction in Western literature. His anti-hero, Satan, travels outside of space and time to get revenge on God, and Milton coined the term 'outer-space' to describe this journey.

His work has inspired our greatest science fiction and fantasy writers, including Mary Shelley, J.R.R. Tolkien, C.S. Lewis, Isaac Asimov, Philip Pullman and Neil Gaiman to name just a few.

MILTON'S LEGACY TODAY

As if that's not enough, Milton's political prose has been a major influence on our parliamentary democracy, as well as the American Declaration of Independence and the French Revolution. He also introduced 630 words into English, from satanic to self-esteem – more than anyone, including Shakespeare!

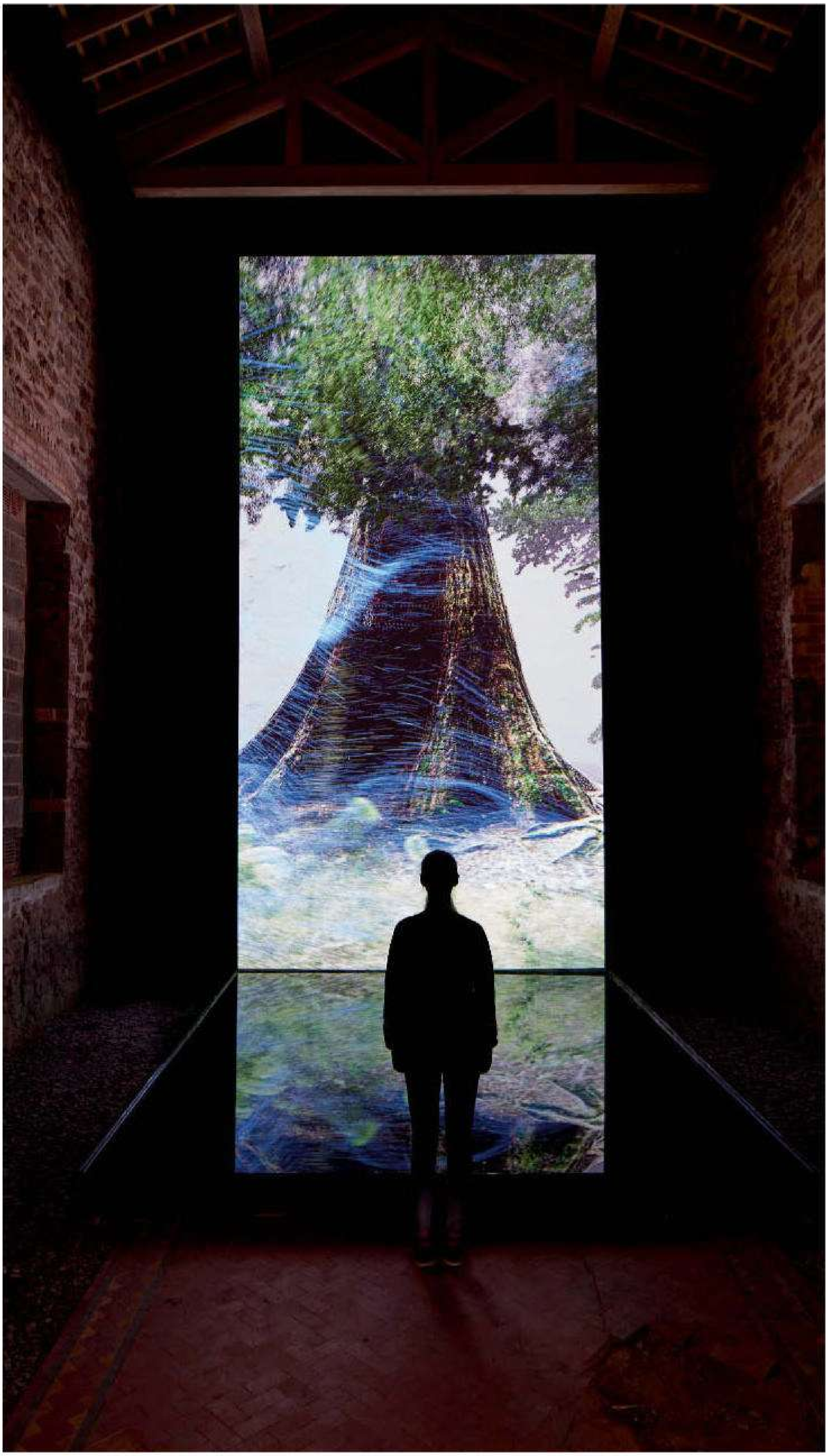
INSPIRING THE NEXT GENERATION

We want to use Milton's writing to continue inspiring people today. From a summer film school to citizen science projects in our garden (planted with trees, flowers and fruits referenced in Milton's poetry) our education programme seeks to creatively engage young people with his extraordinary life, literature and legacy.

We've even worked with them to co-design a new augmented reality app that's transforming one of the world's oldest writer's house museums through new technology.

Want to help?

You can visit Milton's Cottage, in Buckinghamshire, from 1st April to 31st October, Wed – Sunday, 2 – 5pm. You can also support our creative learning activities by becoming a Friend of Milton's Cottage, from £26 per year. For further information please visit www.miltonscottage.org



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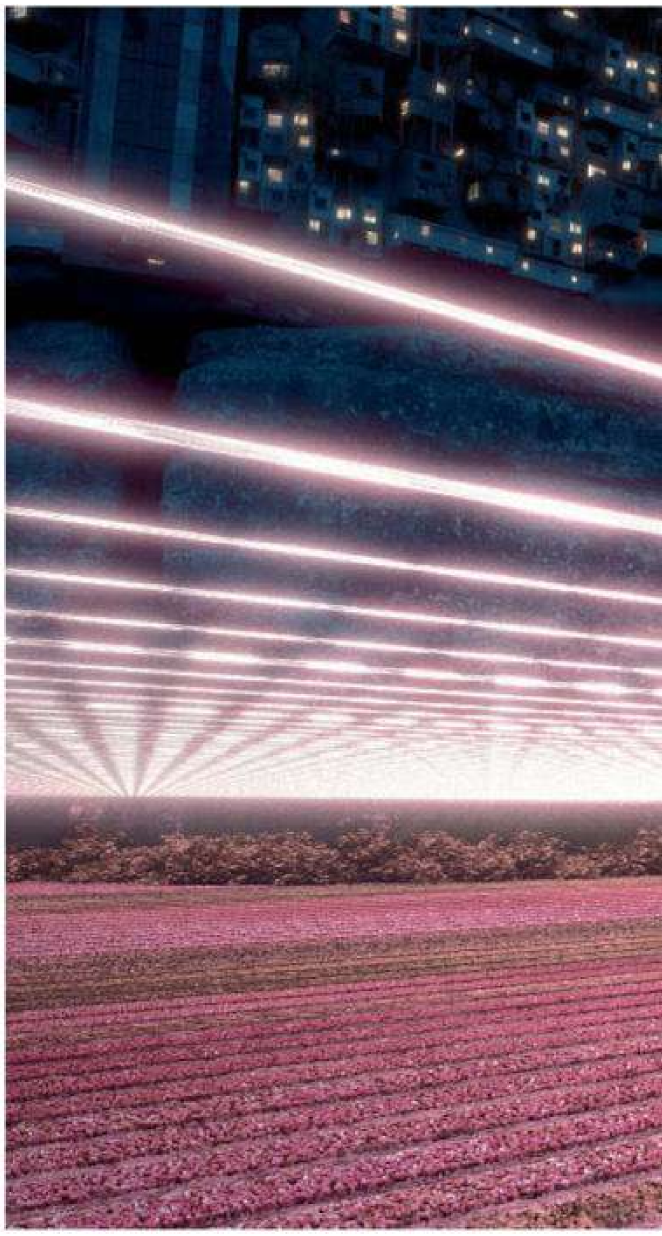

HUMANS AND ANIMALS ARE DEPENDENT ON PLANTS.

TIM P. WHITBY/GETTY IMAGES FOR BARBICAN CENTRE

TIM P. WHITBY/GETTY IMAGES FOR BARBICAN CENTRE

LIAM YOUNG

TIM P. WHITBY/GETTY IMAGES FOR BARBICAN CENTRE

Vital connection

THE complexity, community and precarity of the planet are highlighted in these works from Our Time on Earth, a new exhibition at the Barbican Centre in London. The show aims to "ignite a sense of hope and courage, and to shift people's mindsets to reconnect with the natural world", says co-curator Luke Kemp.

The image at far left is a still from a video called *Sanctuary of the Unseen Forest*, a collaboration between immersive art collective Marshmallow Laser Feast, Andres Roberts – co-founder of The Bio-Leadership Project – and artist James Bulley. It explores our intimate connection with trees and addresses "plant blindness", a human tendency to ignore plants in favour of animals.

The top-right image is a video still from *Planet City*, a film directed by architect Liam Young that imagines a "hyper-dense" city of 10 billion people, allowing the rest of the world to be reclaimed by the wild. It shows a speculative solution for feeding the city's population.

Bottom right is an image from digital art installation *Life Forces* by art duo Tin & Ed, which aims to provide a portal to nature by using human body tracking to allow visitors to interact with digital landscapes.

The two small images are shots of *Sharing Prosperity*, a gaming experience created by DVTK in collaboration with the Institute for Global Prosperity at University College London. Set in the near future, the game explores how collaboration could help the planet to flourish.

Our Time on Earth is on at the Barbican Centre until 29 August. ▮

Gege Li

Editor's pick

Age is a number, not a moveable feast

30 April, p 38

From Mark Nelson, University of Tasmania, Australia

The idea, in your look at ageing, that a person's biological age can differ from their chronological age may not be so useful.

A chronological-aged 37-year-old male marathon runner has the biological age of 25 years for his heart. His skin, due to long training hours of sun exposure, is 42, except in his groin and inner arms, where the sun hasn't been so unkind, and is therefore 37. His left Achilles tendonitis means the tendon is 53 on that side, but 48 on the right. So, what is his biological age?

I think we should just stick to classifying age based on how many times we have orbited the sun and abandon the flawed but attractive idea that we can reverse, stop or slow ageing. We can, however, improve health and fitness.

How ghosting may come to haunt us less

23 April, p 47

From Phil Leask, Bristol, UK

It shouldn't be a surprise that "ghosting" – ending a relationship by cutting all communication without explanation – is painful. It is often a form of humiliation, which is an exercise of power that is arbitrary or unexpected, involves rejection or exclusion, conflicts with what was thought to be a set of shared assumptions about values and expectations, and leaves the recipient feeling diminished and with a sense of injustice with no possible remedy.

The consequences are predictable and consistent, and include bewilderment, rage, a desire for revenge, frustration at one's powerlessness and, often, depression. It won't be surprising if ghosting loses its impact eventually, since people increasingly know it is a likely response in a digital dating world and will choose not to be bothered by it. This would involve a change of expectation: you are likely to behave badly, and since I no longer expect that you will behave, it isn't a surprise, doesn't hurt and I don't feel it as rejection or injustice.

In other words, a form of resistance is built in at the start of a relationship, so that ghosting is no longer an effective exercise of power. Whether this is a healthy way to embark on relationships is another matter, but at least it will reduce the pain of being ghosted.

We need a new name for 'meat' grown in the lab

30 April, p 12

From Helen Senior, Creech St Michael, Somerset, UK

The term "lab-grown meat" is unscientific. Meat is animal flesh. Some of us like to eat it, some don't. Those who don't can have a healthy and delicious diet of vegetables. What you refer to isn't meat and would be better described as "synthetic foodstuffs". At the very least, these products of the laboratory shouldn't be called "meat". Such descriptions mislead the public.

Mountainous Switzerland is full of generous people

Letters, 16 April

From David Myers, Commugny, Switzerland

After reading your report that exposure to mountain landscapes boosts generosity, Bryn Glover asks if the Swiss are inherently so. I believe the answer is yes. For example, on one day in March, an organisation called Swiss Solidarity raised 45 million Swiss francs ($46 million) for Ukraine and this sum has since risen substantially.

Moreover, so far, some 40,000 Ukrainian refugees are being accommodated in Switzerland, and this in a country with one-eighth the population of the UK. The Swiss raised large sums to aid people affected by the 2004 Asian tsunami and on many similar occasions. Whether this generosity is due to Swiss scenery would require more research.

Dogs are far from a plague on the planet

30 April, p 42

From Rachael Padman, Dalham, Suffolk, UK

Aisling Irwin reports that dogs, based on their global impact on wildlife and the environment, can be regarded as an invasive species.

We may make things marginally worse by owning pets, but let us get it into perspective. There are far fewer dogs than people and, for the most part, they are a lot smaller. They haven't discovered fire and learned to extract and burn fossil fuels, they don't fly long haul for holidays and they don't buy consumer electronics that they discard after a few years.

Nuclear waste is far from a deal-breaker

Letters, 30 April

From Roger Clifton, Darwin, Northern Territory, Australia

Paul Whiteley asserts that nuclear power doesn't add up for five reasons. However, these aren't intractable engineering problems at all, they are bogeys created and maintained by scaremongering, a very human problem.

Generating a kilowatt of electricity per person for a year results in only 1 gram of fission products, easily buried, whereas the absence of nuclear power dumps tonnes of carbon dioxide into the atmosphere. That is a very good reason for the fearmongers to change sides.

Want to get in touch?

Send letters to letters@newscientist.com; see terms at newscientist.com/letters

Letters sent to New Scientist, Northcliffe House, 2 Derry Street, London W8 5TT will be delayed

We could just recycle waste into solid wall insulation

Letters, 30 April

From Barry Cash, Bristol, UK

My house has solid walls and I have found insulating them to be prohibitively expensive – a point highlighted by Robert East. I was quoted £15,000 for my three-bedroom end-of-terrace property. So I started thinking, could I do it myself?

We have a lot of unwanted clothes. Charity shops dispose of 80 per cent of the clothes they are given as unsaleable. Clothes insulate. Could I insulate my house by attaching some to the outside walls in airtight plastic containers?

I made a cup of tea to think it over and realised I was rinsing and recycling an airtight plastic milk container. It is square at the bottom, but not all the way up. Now, I am trying to work out how to fit them to the walls and what to cover them with to make the house look presentable. Suggestions welcome.

How safe will it be to store so much carbon dioxide?

23 April, p 19

From Norman Wilson, Halton, Lancashire, UK

The story on the carbon removal plant in Iceland is one of almost weekly articles referring to carbon dioxide storage as a means of fighting climate change. To have a significant effect, tens if not hundreds of millions of tonnes will have to be stored each year.

Could there be hazardous leaks? Recall the release of CO_2 in 1986 from Lake Nyos, a volcanic crater lake in Cameroon. An estimated 100,000 to 300,000 tonnes of CO_2 were released. The best estimate is that more than 1700 people and many livestock died.

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Codes, cyphers and a cuppa

A moving exhibition at Bletchley Park shows women's crucial contribution to the success of the UK's wartime intelligence centre, finds **Nicholas Wroe**

Exhibition

The Intelligence Factory, and The Art of Data

Bletchley Park, UK

RALPH APPELBAUM ASSOCIATES

There are huge maps and charts on which analysts tracked shipping convoys

THROUGH movies like *Enigma* and *The Imitation Game*, we think we know all about Bletchley Park, the UK government intelligence centre in Buckinghamshire that broke the codes and cyphers of the Axis powers and changed the course of the second world war. But there are, it turns out, still plenty more stories to tell.

The Intelligence Factory, a permanent new exhibition on the Bletchley Park site, which has been a museum since 1993, mostly steers clear of the achievements of the likes of Alan Turing. Instead, it seeks to recreate the unsung work, also invaluable to the war effort, undertaken by the large and largely anonymous cast of more junior workers. This was predominantly young women, who enabled Bletchley to gather and disseminate "the product", as it described its intelligence, to Allied forces and politicians.

Visitors can see historic objects – often in the rooms where they were used in wartime – such as a Hollerith tabulating machine and its punch cards, which became a stepping stone to modern computing. There are huge maps and charts on which analysts tracked shipping convoys in near real time, interactive elements to illustrate the problem-solving that took place, and impressive examples of early analogue data management, storage and visualisation systems – all of which have direct parallels today.

But The Intelligence Factory also features diaries, home movies and even teddy bears belonging to workers, mixing the intensely personal with the wider picture of ordinary people taking on an extraordinary task.

The sheer scale of the endeavour is overwhelming: you even enter through a large loading bay built to accommodate the delivery of 2 million punch cards every week to feed the Hollerith machines.

When war began, Bletchley was likened to a small university. It succeeded in cracking codes, but the sheer weight of information it received became ever more unmanageable. Over the years, it dramatically scaled up to something closer to a factory. By the end of the war, 9000 people were on site, 75 per cent of them women. Their work – such as punching those cards – was often mind-numbingly repetitive, and they had little or no idea where they fitted into the bigger picture.

> "Staff were forbidden to speak about their work, even to colleagues. Unsurprisingly, morale was a major concern"

They were also forbidden to speak about their work, even to colleagues. Unsurprisingly, morale was a major concern for Bletchley's leadership, and its famous tennis courts as well as its concerts and societies were a stab at addressing the issues. But logistics were even more of a headache

Feeding, housing and transporting the workforce became as much a focus as the logistics of collating, sharing and making retrievable the vast swathes of information (all on paper) across the site. The exhibition shows both activities, with food playing a prominent role. A newfangled idea – the canteen, copied from the Kodak factory in Harrow – was introduced to improve efficiency.

Scattered across the exhibition are modern applications of ideas developed at Bletchley in the 1940s. These include an Encrochat phone used by criminal gangs, whose encryption was cracked by international crime agencies, and algorithms that identify suspicious shipping movements.

Another new exhibition on the site, The Art of Data, also explores data visualisation through strikingly visualised 21st-century uses, from heat maps tracking swimmers in an Ironman race to the movements of the local Milton Keynes Dons football team during a match.

Behind all this, the human element shines out, as it did in wartime. It was the quiet skills of organisation and resilience as well as genius minds and cutting-edge innovation that allowed Bletchley to succeed. In the end, The Intelligence Factory is a moving and inspiring story of a myriad small jobs being done by ordinary people that together amounted to something very special. ▮

Nicholas Wroe is a writer and editor, based in London

The cycle of life

A fundamental process in our cells may explain the origin of life and the cause of cancer, finds **Michael Marshall**

Book

Transformer: The deep chemistry of life and death

Nick Lane

Profile Books

IF WE want to understand the nature of life, we have to think about the flow of energy and matter. So argues biochemist and writer Nick Lane in his new book *Transformer*. Quoting the poem *Like Most Revelations* by Richard Howard, he writes that "it is the movement that creates the form".

Lane's focus on energy and the essential dynamism of life has been an important thread running through his research. One of the most creative of today's biologists, his work ranges from the evolution of sex and the rise of planetary oxygen to the origin of complex cells and the first life on Earth.

In his last book, *The Vital Question*, he argued that many of these seemingly disparate mysteries could be explained by life's reliance on electrically charged particles to power itself.

Transformer is no less ambitious. Its focus is a biochemical process called the Krebs cycle: a whirlwind of chemistry that spins around in all our cells many times a second. It is named for biochemist Hans Krebs, who described many details of how it works.

Lane's thesis is that biochemists have misunderstood the cycle and therefore underestimated it. Textbooks, he says, essentially treat it as a mechanism for obtaining energy from food. But Krebs is also a chemical factory, manufacturing key components of cells. And cells can run it in various ways, so there is no one Krebs cycle. Lane compares it to a furiously busy roundabout, with different vehicles constantly whizzing in from different junctions and hurtling out on others.

The many functions of the Krebs cycle mean it can explain much about life, Lane argues. For one thing, the cycle can run backwards, and this reverse Krebs seems to be much older than the "forwards" one. Lane makes the case that it dates back to the very earliest life, which he believes arose in hydrothermal vents on the seabed. He draws on recent experiments suggesting that parts of the reverse Krebs (and at least some of the forwards Krebs) can happen without complex biochemicals to shepherd them along, and may therefore be primordial.

Moving through the history of life, Lane illustrates the deep links between the reverse Krebs and photosynthesis, which, in turn, led to Earth's air becoming rich in oxygen for the first time – paving the way for the modern Krebs, which requires oxygen. He also argues that alterations in the cycle may have been key to the blossoming of animal diversity during the Cambrian explosion some 540 million years ago.

Lane brings the story up to date by delving into the role of Krebs in cancer. Our understanding of the disease, like our understanding of life, has been skewed by an undue emphasis on genes, says Lane. For him, the key to cancer (as to so much else) is metabolism: it is shifts in cellular metabolism, not genetic mutations, that explain why our risk of cancer increases so drastically as we age.

If that weren't enough, Lane even suggests that the electromagnetic fields generated by metabolic processes like Krebs may be the underpinning of consciousness.

Clearly, this is a book filled with big ideas, many of which are bold instances of lateral thinking. Lane says he doesn't expect to be right about all of it, but that is fine – even the bits that are wrong will advance our knowledge in the disproving.

It is a shame, then, that his book can be dry at times. There is a lot of nitty-gritty biochemistry – some of it essential, but described in exhausting detail. Get ready to hear an awful lot about succinate, pyruvate and alpha-ketoglutarate. Lane tries hard to imbue these chemicals with personality, but his efforts only go so far. Those who persevere will get a lot out of *Transformer*, but it is hard work. ▮

The Krebs cycle may be like a busy roundabout, as vehicles whizz in and out from different junctions

NUCHA SIRIVISANSUWAN/GETTY IMAGES

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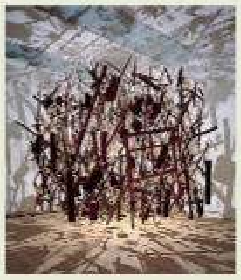
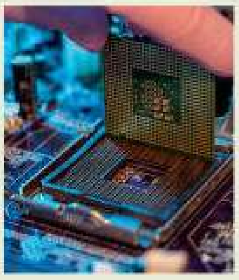


Visit

Cornelia Parker brings mesmerising, large-scale installations to London's Tate Britain gallery. Expect frozen moments, exploded art (see above), perceptual games and glimpses into deep time. Open from 19 May.

Watch

The Time Traveler's Wife is a mix of sci-fi and romance, in which protagonist Henry (Theo James) flitters uncontrollably through time, and his wife Clare (Rose Leslie) has to put up with him. Streaming on Sky Atlantic and NOW TV from 16 May.



Listen

The Academy of Robotics, which has launched and tested some of Europe's first self-driving cars, examines how tech is transforming its own funding structures in a six-part podcast on the Clubhouse audio app.

CORNELIA PARKER; HBO; ARTEM OLESHKO/ALAMY

The film column

Law versus science A low-income Chilean community faces down the Swedish company whose toxic sludge was dumped near its homes. *Arica* tells the gut-wrenching story of their fight for justice, finds **Simon Ings**

Simon Ings is a novelist and science writer. Follow him on Instagram at @simon_ings

Film

Arica

Lars Edman and William Johansson

Selected UK cinemas

Simon also recommends...

Film

Stalking Chernobyl

Iara Lee

A gripping documentary about efforts to explore and resettle the exclusion zone around the Chernobyl nuclear site.

Book

White Noise

Don DeLillo

Picador

DeLillo's breakout novel is a claustrophobic exercise in environmental paranoia.

DAGENS NYHETER.
De har vetat om att det skulle gå åt helvete och bli ett miljöproblem.
Förgiftad av svenskt gruvslam – 100-tals barn stämmer Boliden

LAIKA FILM AND TELEVISION

Waste from Swedish firm Boliden was dumped near a town in Chile

FORTY years ago, Boliden, a Swedish multinational metals, mining and smelting company, sold nearly 200,000 tonnes of smelter sludge rich in mercury, arsenic, lead and other heavy metals to the Chilean reprocessing company Promel. The latter dumped most of it next to a row of houses in Arica in northern Chile.

Over the years, this community of low-income families swelled until it surrounded the site of contamination. A generation of children grew up playing in the sludge. In 1999, the Chilean government struck an uneasy peace with those affected by this avoidable catastrophe. Promel no longer exists. Families closest to the site have been evacuated.

Swedish film-maker Lars Edman returns to the country of his birth and the site of his 2010 *Toxic Playground* documentary for a follow-up. *Arica* concentrates on the legal case against Boliden, whose due diligence on toxic materials has come under serious question. Boliden denies responsibility, saying it followed applicable regulations and believed the waste would be processed safely. Any negligence, it argues, is attributable to Promel and the Chilean authorities.

The chief protagonist of Edman's first film was Rolf Svedberg, Boliden's former head of environmental issues. It was his site visit and report that green-lit the sale and transport of what Boliden's legal team calls "material of negative value".

> **"The UN sent experts into Arica. Their findings shamed both the company and the Swedish government"**

Brought face to face with the consequences of that decision, and hosted by a community riddled with cancer and congenital conditions, Svedberg's distress was visible. A decade on, though, he has the legal case to think of, not to mention his current role as a judge at Sweden's environmental supreme court.

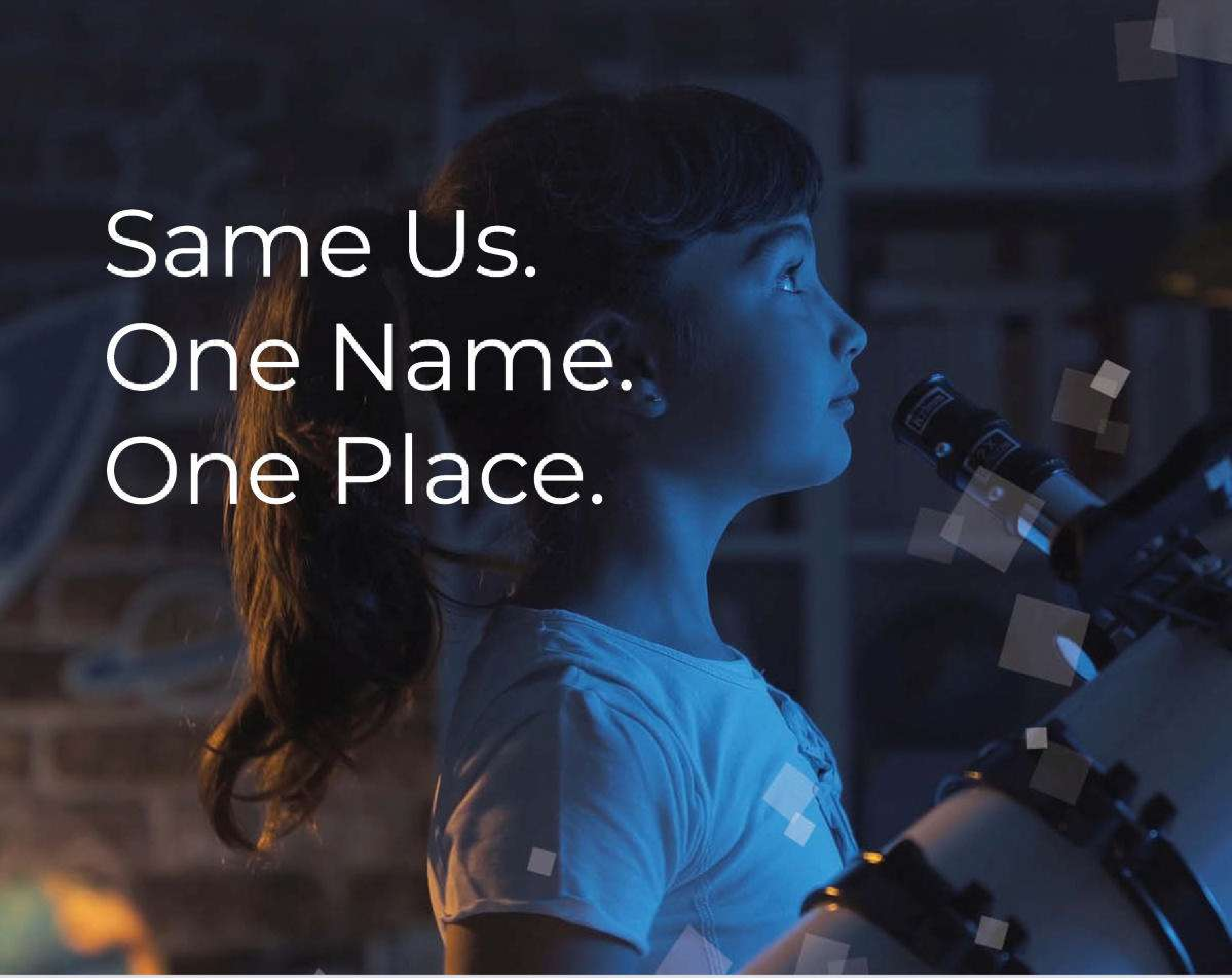
Boliden's legal consultants bring in experts who assemble arcane explanations and a ludicrous wind-tunnel experiment to show that living next to tailings containing 17 per cent arsenic couldn't possibly have affected anyone's health. Opposing them are 800 plaintiffs (out of a community of 18,000) armed with a few urine tests from 2011 and evidence that would be overwhelming were it not so frustratingly anecdotal.

One interviewee, Elia, points out houses from her gate. "The lady who lived in the house with the bars," she says, "sold the house and died of cancer. Next door is Dani Ticona. She had aggressive cancer in her head and died too. And her son's wife had a baby who died..."

Boliden's team performs a familiar trick, sowing doubt by suggesting that lab and field science are the same thing, with identical standards of proof. If the company had to address average consumers rather than Arica's low-income residents, it would long since have saved money and its reputation by owning the problem. But Boliden deals with corporations and governments. Its image rests on problem-free operations; it pays to stay silent.

In the end, the community loses, but in 2021 the UN sent experts into Arica. Their findings shamed both the company and the Swedish government.

Law is a rhetorical art. We like to think justice can be scientifically determined, but that is to misunderstand science and the law. Tragedy, poverty, blame and shame cannot be reduced to numbers. Protest, eloquence and argument are as essential for justice as they were in the making of this elegiac film. ▮



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Your second skin

A long-ignored body tissue could be a new sensory organ that holds the key to tackling chronic pain. **Caroline Williams** investigates

SCIENTIFIC revelations come from the unlikeliest of places. Like a rat, in a lab, doing a "downward dog" stretch.

According to the people who found a way to get rats to do yoga, these creatures benefit from a good stretch as much as we do. In the process, they are revealing the true significance of a body tissue that has been overlooked by science for centuries.

The 19th-century anatomist Erasmus Wilson called this tissue – now known as fascia – a natural bandage. In dissection, that is exactly what it looks like: sheets of white, fibrous connective tissue that are strong yet flexible and perfect for keeping muscles and organs in place. They are also sticky, gloopy and get in the way of looking at the muscles, bones and organs they cover. Which explains why, for years, anatomists cut this tissue off, chucked it away and thought little more about it.

Recently, though, researchers have begun to take a fresh look at fascia and are finding that it is anything but an inert wrapping. Instead, it is the site of biological activity that explains some of the links between lifestyle and health. It may even be a new type of sensory organ. "There appears to be more going on in the fascia than is commonly appreciated," says Karl Lewis at Cornell University in Ithaca, New York.

We are now realising that a better understanding of this ubiquitous tissue is sorely needed. If we manage to figure it out, it has the potential to provide new ways to tackle many common yet hard-to-treat conditions, from immune dysfunction to chronic pain.

One difficulty with studying fascia is that there is disagreement about what it actually is. It comes under the umbrella of connective tissue, which, at its broadest definition includes not only tendons and ligaments, but also bone, skin and fat.

Most fascia researchers, however, understand it to be sheets of tissue made up of strong collagen fibres and more stretchy elastin fibres. In many places, these fibrous sheets are separated by "areolar" or "loose" fascia, a form that contains fewer fibres and with the gaps between fibres filled with a slimy substance that allows the surrounding layers to slide over each other. The main ingredients of this slippery soup are hyaluronic acid, for lubrication, and proteoglycans, molecules that provide cushioning. The fascia fibres and the soup are both secreted by specialised calls in the tissue – fibroblasts and the recently discovered fasciacytes.

Holding us together

If you were to cut into the body, you would find two obvious layers of this natural cling film: the superficial fascia, which sits directly under the skin, and the deep fascia, which wraps muscles and organs and connects them to each other. Some researchers, however, extend the definition to include the visceral fascia, which lines the body cavity and divides it into compartments for different organs, and also thin layers of connective tissue that line pretty much every part of the body. By this definition, fascia forms a network that pretty much holds us together (see "A body-wide network", page 40).

Remarkably, until the early 2000s, no one had studied this common tissue in detail. Among the first to do so was Carla Stecco, an orthopaedic surgeon and anatomist at the University of Padova in Italy. She started studying fascia 20 years ago when her father, a physiotherapist called Luigi Stecco, invented a form of physical therapy called fascial manipulation, which he claimed could treat everything from headaches to muscle and joint pain. His system is now one of many physical therapies that hinge on the idea that fascia can become stiff, and that it can be "released" through massage.

The only problem was that there was no evidence for or against the idea that physically manipulating the body did anything specifically to the fascia, or that this would affect pain. And as Carla Stecco soon discovered, there wasn't even a body of literature explaining, in detail, what fascia actually was. It wasn't even known if it had nerves associated with it, she says.

Since then, she and others have shown that fascia is indeed rich in nerves, and that the information that these relay varies throughout the body. Superficial fascia contains nerves that specialise in sensing pressure, temperature and movement. Deep fascia is involved in proprioception, the body's sense of its position in space, and nociception, the sensing of pain.

Because of this sensory role, some researchers say that fascia should be considered a new organ, one that is

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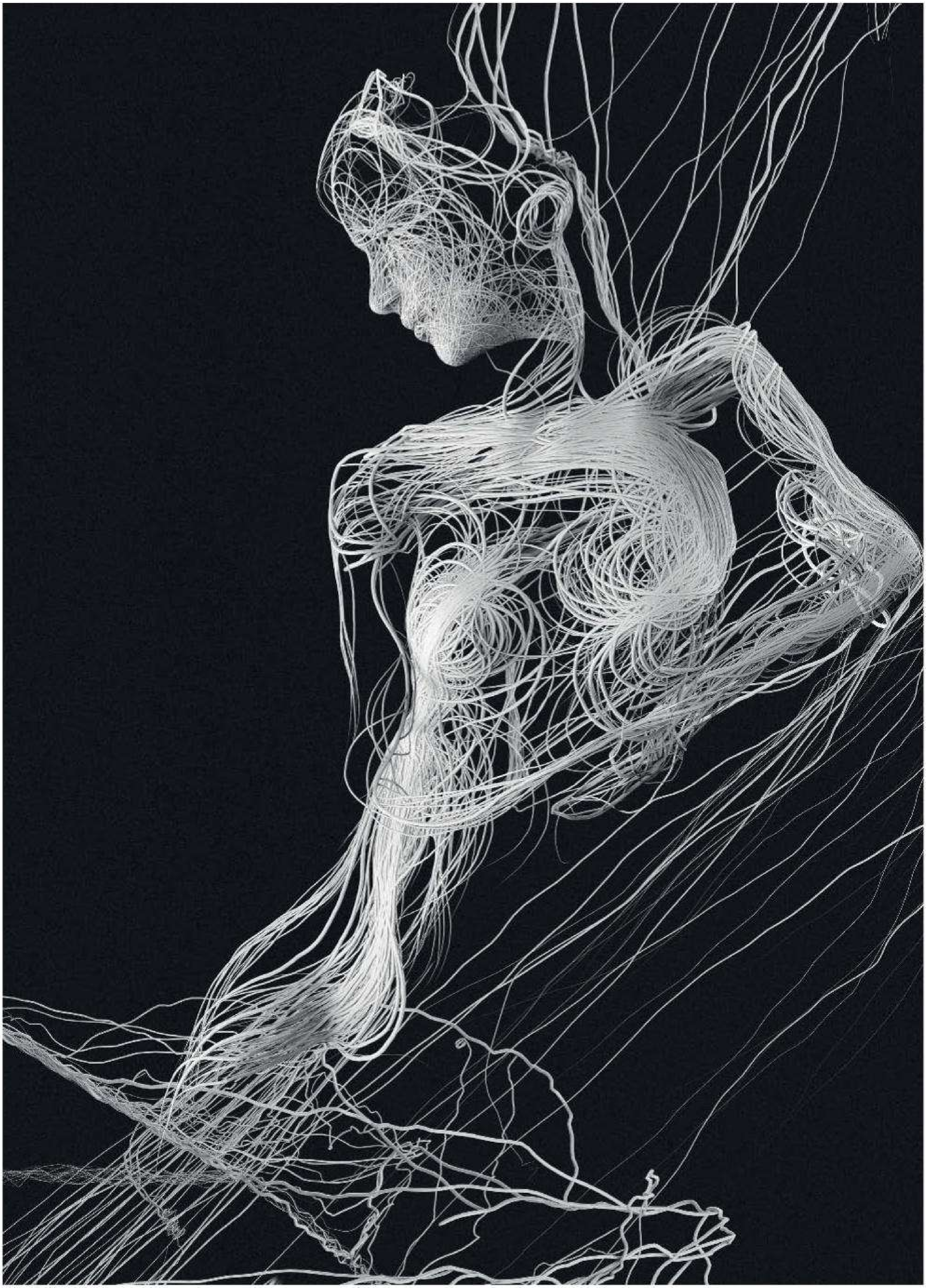

JANUSZ JUREK

specialised for communication about the body's internal state. Robert Schleip at the Technical University of Munich in Germany recently estimated that an adult's fascia contains approximately 250 million nerve endings, similar to, or slightly more than the skin. "It is beyond any doubt our richest sensory organ," he says. Others are more cautious. "It's plausible, but there is a strict definition for an organ to do with material organisation, cell types and function, so it sounds like it's a candidate," says Lewis. "But it's early days for making that determination."

"Fascia is anything but an inert wrapping"

Organ or not, there is evidence that deep fascia specialises in a different kind of message to other bodily tissues. Experiments in which healthy human volunteers had painful injections into their skin, muscles and fascia showed that while nerves in the skin and muscles produce focused, localised pain, the network of nerves in fascia is linked to a radiating pain, one that is more difficult to pinpoint. This kind of diffuse pain is a feature of several chronic pain disorders, including fibromyalgia, which some studies have linked to inflammation in the fascia. It is also a feature of post-exercise soreness, which has long been blamed on damage to the muscles, but which some researchers now think has more to do with injury or inflammation in the fascia.

The bad news for anyone with inflamed fascia is that if it continues for too long, the body responds by altering the composition of fascial nerves to become more sensitive to pain. In rats, the percentage of nociceptive fibres – pain receptors that respond to harmful stimuli – in the fascia increased from 4 per cent to 15 per cent following chronic inflammation of deep fascia in the lower back.

This could help to explain why lower back pain is so difficult to treat. Despite being one of the most common causes of work absence and overall movement restriction, 85 per cent of cases worldwide are classified as non-specific, meaning the exact cause can't be established.

Given what we now know about nerves in the fascia, the thoracolumbar fascia, a diamond-shaped, multilayered structure in the lower back in which different layers connect to different muscle groups in the trunk, is starting to look like a good place to put the blame for this back pain. "The thoracolumbar fascia is like a big receptor that is able to feel the tension coming from the upper limbs, the spine and the abdomen," says Stecco. The sensory neurons in the fascia may respond to this tension by registering it as pain.

On top of nerve changes, inflammation in the loose, areolar fascia that is found between fascial layers can make matters worse. Helene Langevin at the US National Institutes of Health in Maryland used ultrasound imaging of the lower back to show that people with chronic lower back pain had thoracolumbar fascia that was 20 per cent stiffer than those without this pain.

This stiffness seemed to be explained by multiple layers of tissue becoming stuck together, stopping the loose layer from sliding. Her studies in pigs have backed this up, showing that even after an initial injury has healed, a lack of movement in the lower back can be enough to keep the fascia stiff and to cause adhesions, where two layers become physically linked by new collagen fibres. This, other studies suggest, restricts movement, not only in the fascia immediately surrounding

A body-wide network

Our understanding of how fascia affects health (see main story) depends on where you draw the line between where it begins and ends in the body.

Some people think that as well as the distinct layers of this tissue found under the skin and surrounding muscles, the term should also cover the interstitium: the fluid-filled connective tissue that lines every organ, muscle fibre and blood vessel.

If that is correct, the fascia makes a whole-body network of fluid that could function both as a shock absorber and an immune network relevant to inflammatory disorders, scar formation and the spread of cancer.

The true nature of the interstitium only became apparent in 2018 when a study by Neil Thiese at the Icahn School of Medicine at Mount Sinai, New York,and his colleagues used a new microscopic technique to look at its structure in a living person undergoing a biopsy. In the past, it was only possible to see this tissue by removing it and squashing it on a microscope slide. When seen in living tissue, what had previously looked like a dense tangle of fibres actually had a sponge-like structure filled with fluid that drained into the lymphatic system, part of the body's immune set-up.

The team suggested that physical movement may help keep this fluid healthy, whether due to the pumping of the heart, the movement of the digestive tract or physical movement of the body. "It seems that no such spaces are static," says Thiese. This discovery opens up the possibility that the body is connected in ways that we are only beginning to understand and that movement is required to keep this tissue healthy.

PROF. P. MOTTA/DEPT. OF ANATOMY/UNIVERSITY "LA SAPIENZA", ROME/SCIENCE PHOTO LIBRARY

Fascia is a connective tissue made up of fibres of the proteins collagen and elastin

the stiff spot, but also in connected regions nearby. In particularly severe cases, fascial layers can become stuck into one immobile block that runs from the superficial fascia to the deep fascia and into the muscle.

Injury and inflammation aside, there are many other reasons why fascia may become stiff. Schleip's research hints that activation of the sympathetic nervous system, which is involved in the body's fight-or-flight response, causes the fascia to contract by prompting the fibroblasts within it to transform into myofibroblasts, cells that are part of the inflammatory response to injury, often seen in joint-related problems such as frozen shoulder.

The details of how exactly fight-or-flight stress leads to stiffness are still being worked out, but Schleip says that adrenaline seems to increase the expression of an inflammatory substance called TGF-beta. This is then stored in the loose fascia in preparation for the next time the body is stressed. When this happens, fibroblasts "drink [TGF-beta] and they become myofibroblasts in a few hours", he says. "And then they are four times as strong as before. They are contraction machines. So, adrenaline can make fascia stiffer."

In fact, the list of things that affect fascial stiffness is getting longer all the time. "Oestrogen is able to create a fascia that is more elastic," says Stecco. "The fascia is a very dynamic tissue that is able to answer to hormonal input, chemical input and mechanical input. Altogether, that defines if our fascia is elastic or rigid."

On the plus side, this dynamic nature of fascia suggests that lifestyle changes could help to reverse problems related to it. One promising intervention under investigation is stretching. In samples of rat tissue, Langevin found that stretching causes changes to the fibroblasts that make up the matrix of the loose fascia. She says they expand several fold and become longer and flatter. "Stretching the tissue allows it to relax," she adds.

Stretch it out

Other studies by Langevin with pigs showed that stretching the lower back for 5 minutes, twice a day, not only reduced the size of an area of inflammation, but also seemed to induce a series of anti-inflammatory chemical events from the fascia. This is a promising finding because chronic inflammation has been linked to pretty much every modern ailment going, from heart disease and diabetes to cancer and depression.

A team at Harvard Medical School is conducting a trial in people to find out if the same is true in humans. A pilot study completed in late 2021 showed that healthy volunteers who undertook an hour-long stretching session had altered levels of immune system molecules called cytokines, compared with those who didn't stretch, suggesting that there is a regulation of inflammation after stretching.

Future studies will assess whether levels of resolvins, chemicals made by the body that turn off inflammation, also increased, as has been seen in rat and pig stretching studies. If so, stretching could prove useful for reducing cases of more widespread chronic inflammation, which can be triggered by long-term stress, obesity and bad diet.

As for physical therapies that focus on fascia release, such as massage, it is unclear whether they have the same cellular and anti-inflammatory effects as stretching seems to, or whether they simply make temporary changes to the fascia. It could be, for example, that manual therapies warm the tissues, which has been shown to make the fascia matrix less viscous, temporarily allowing the layers to slide more easily. Langevin sounds a note of caution, that until more is known about what happens during these therapies, it isn't clear what, if anything, they do to the fascia, or anything else.

In order to turn fascia research into evidence-based treatments, this tissue will also have to overcome its image problem among scientists. This dates back to the 1940s and 50s, when medical researchers were paying little attention to the stuff, and it became central to an alternative approach to health invented by the late biochemist Ida Rolf. Her method, which she called structural integration, but which is better known as Rolfing, is a mixture of physical therapy and claims about alignment of bodily energy fields. Since then, fascia has become a buzz word in all kinds of alternative therapies.

Stecco, however, thinks that it is high time for the mainstream medical profession to start paying attention to this tissue. She would like fascia to be recognised as important to many areas of medicine, and as a window into our overall health. This, she says, would be "the true revolution of the fascia". ∎

Caroline Williams is a freelance writer based in Godalming, Surrey, UK, and author of *Move! The new science of body over mind*

Different minds

Animal intelligence takes many forms, but there may be a way of comparing them – and seeing how we fit in, finds **Ute Eberle**

ANDREA IZZOTTI/SHUTTERSTOCK

Dolphins and corvids are well known for their smarts, but many animals possess surprising abilities

ALEX COOPER PHOTOGRAPHY/SHUTTERSTOCK

> **"A periodic table of intelligence could categorise nature's varied cognitive skills"**

IF YOU have ever concluded that intelligence is in short supply in the modern world, perhaps you are looking in the wrong place. Humanity may seem to be suffering from collective stupidity, but there are still plenty of smarts to be found elsewhere.

You will be familiar with the clever antics of whales and dolphins, chimpanzees and orangutans. But what about wasps? They can recognise human faces. Or crabs? They use stinging anemones to defend themselves against predators. Then there are alligators that place sticks on their snouts to catch egrets looking for nesting material. And mosquitoes can learn to avoid pesticides after a single taste. Plants show intelligence too. A parasitic vine called a dodder sniffs out its prey with remarkable discernment, for example. Blobby yellow things called slime moulds can learn and teach each other. Even biofilms – collectives of bacteria – possess short-term memory and the ability to make decisions.

Such an astonishing array of aptitude is rather unsettling. It also raises some fundamental questions, including what actually is intelligence, how did it evolve and how do the abilities of various organisms compare? These are hard to answer. Evaluating intelligence in nature is tricky, particularly in life forms that are very different from us. But now a group of neuroscientists, AI researchers and philosophers have come up with a radical idea. They want to create a periodic table of intelligence akin to the one used to categorise the chemical elements. If they succeed, it could radically alter the way we see other species – and ourselves.

It is a bold plan. When the Russian chemist Dmitri Mendeleev invented the periodic table in 1869, his contemporaries immediately recognised it as a monumental feat. It has been called "nature's Rosetta Stone" and is still seen as one of science's foremost breakthroughs. By ordering the chemical elements into columns and rows, the table transformed the somewhat mystical field of chemistry (think alchemy) into a powerhouse of hard science. Researchers need only note the position of an element in the table to tell whether it might react vigorously with water, for example, or is likely to conduct electricity. The table has even predicted elements that were subsequently discovered.

Researchers working on a project called Diverse Intelligences hope that a periodic table of intelligence can categorise nature's varied cognitive abilities in a similar way. But where even to begin? The chemical version sorts elements by their atomic number or atomic mass. For intelligence – broadly defined as an organism's ability to flexibly respond to a changing environment – researchers are still looking for a criterion that is equally straightforward.

It certainly isn't brain size, as was long thought. Adult human brains weigh between 1.2 and 1.5 kilograms, contain about 86 billion neurons and make up about 2 per cent of our body weight. But a whale's brain can weigh 9 kilograms, an African elephant has some 257 billion neurons and the brain of a shrew – a small, mouse-like creature not renowned for its smarts – comprises about 10 per cent of its body mass. What's more, honeybees seem able to count up to 5 and grasp the abstract concept of zero with a brain measuring less than 2 cubic millimetres.

Behaviour might be a better way to categorise cleverness. Take the courting male cuttlefish that positions himself between a female and his rival and displays female colours on the side of his body facing his competitor and male ones on the side that the female can see. Or consider a rook. If this bird is presented with a treat floating in ›

Bees can grasp the abstract concept of zero

MARK HORTON/ALAMY

a water-filled vessel, it drops stones into the liquid until the level has risen high enough to bring the tasty morsel into reach.

But testing for intelligence through behaviour is difficult. Recognising oneself in a mirror is seen as a sign of advanced cognition. Dolphins, magpies and manta rays can do it – but dogs typically can't. Does this reflect a lack of intelligence in canines or perhaps something else, such as their reliance more on smell than vision? Likewise, many organisms live in environments that are starkly different from ours and so might use senses that we don't even possess. A shark in its watery, buoyant, blue-green world senses nearby animals through their electrical field. How does that shape its cognition?

Nevertheless, the researchers behind the Diverse Intelligences initiative think intelligence might become more transparent through a combination of behavioural and neuroanatomical features. "We're going to ask, are there kinds of intelligence, and can we identify structural features that are organisational of those kinds of intelligence?" says Andrew Barron at Macquarie University in Australia. "If we can, then we are starting to identify things that could be thought about as possible dimensions [of intelligence]."

Smart selection

Evolution will be a guide. Intelligence seems to have emerged many times and brains take a variety of forms. The researchers hope to gather crucial insights by looking at these different architectures. Jellyfish, for instance, possess a decentralised network of neurons, in which all nerve cells tend to be connected to all others. Worms and sea slugs have a series of dispersed neuron clusters. In vertebrates, the neurons work in loops that feed back into each other. And so on. In each of these architectures, information is organised, processed and spread differently.

Consider the cephalopods, a class of animal that includes octopuses and cuttlefish. They diverged from the evolutionary path that resulted in humans about 600 million years ago, and the architecture of our brains is remarkably different. An octopus possesses about 550 million neurons, of which around 160 million sit in its large optic lobes and 42 million inside a brain shaped like a doughnut because the oesophagus runs through it. Even more neurons – about 350 million – are distributed among the animal's eight arms, which constantly explore the environment and process information, basically "thinking" independently. Yet cephalopods seem highly intelligent. An octopus will easily open a jar – an object that hasn't been part of its evolution. And cuttlefish can resist the temptation to eat a treat to get rewarded with a better one a while later. In this version of the marshmallow test, they manage to delay gratification for up to 2 minutes, broadly similar to chimpanzees.

> **"Intelligence emerged many times and so brains take a variety of forms"**

Jellyfish have decentralised brains, octopuses are highly intelligent and a shrew's brain is 10 per cent of its body mass

IVAN KUZMIN/ALAMY; BLICKWINKEL/ALAMY

A.MARTIN UW PHOTOGRAPHY/GETTY IMAGES

Barron and his colleagues suspect that different neuronal architectures have distinct cognitive advantages and limitations. Decentralised information processing might be faster, for example. Conversely, channelling everything through a central brain could create cognitive bottlenecks. By scouring the literature and performing new experiments, the team will probe the capabilities of a range of animals representative of various cognitive architectures to find out whether a particular brain structure translates into identifiable abilities and limits to learning, which can be used to categorise intelligence into groups. "The breakthrough with the chemical periodic table was realising that there are structural properties in the elements that organise the table," says Barron. "When you have that, suddenly you have explanatory power." He hopes to even incorporate artificial intelligence into the table, to see how it differs from natural intelligence.

"Looking at how organisms pull together information makes sense," says Juliane Bräuer, who researches animal cognition at the Max Planck Institute for the Science of Human History in Jena, Germany. She isn't involved in the project, but welcomes it. As do others. We need to think about "how we can break down our understanding of intelligence into more atomic parts so that we can see how different kinds of intelligence cut across the tree of life", says Kensy Cooperrider at the University of California, San Diego. He hosts a podcast called Many Minds and is working on a somewhat-

“Different brain architectures may have advantages and limitations”

L: ERIC BACCEGA/AGEFOTOSTOCK/ALAMY; R: AMAZON-IMAGES/ALAMY

Mosquitoes are fast learners, while African elephant brains have far more neurons than ours

related project that tries to map out non-human cognition into an Atlas of Intelligences.

However, not everyone is convinced that a periodic table of intelligence can succeed. “Is it meritorious? Obviously. Is it realistic? I’m not so sure,” says Edward Wasserman at the University of Iowa, who has spent five decades studying the cognitive abilities of eight species, including humans. It is extremely difficult even to systematise intelligent behaviour, he says. “There are so many variables that critically determine the results. It’s mind-boggling.”

Blurred lines

Barron admits that the whole concept might be completely wrong. “There could be no clear boundaries between the different dimensions of intelligence – they could be blurred,” he says. If this were the case, there would be no meaningful structure and, hence, no periodic table. “But even if it falls over, we’ll have learned a lot,” he says.

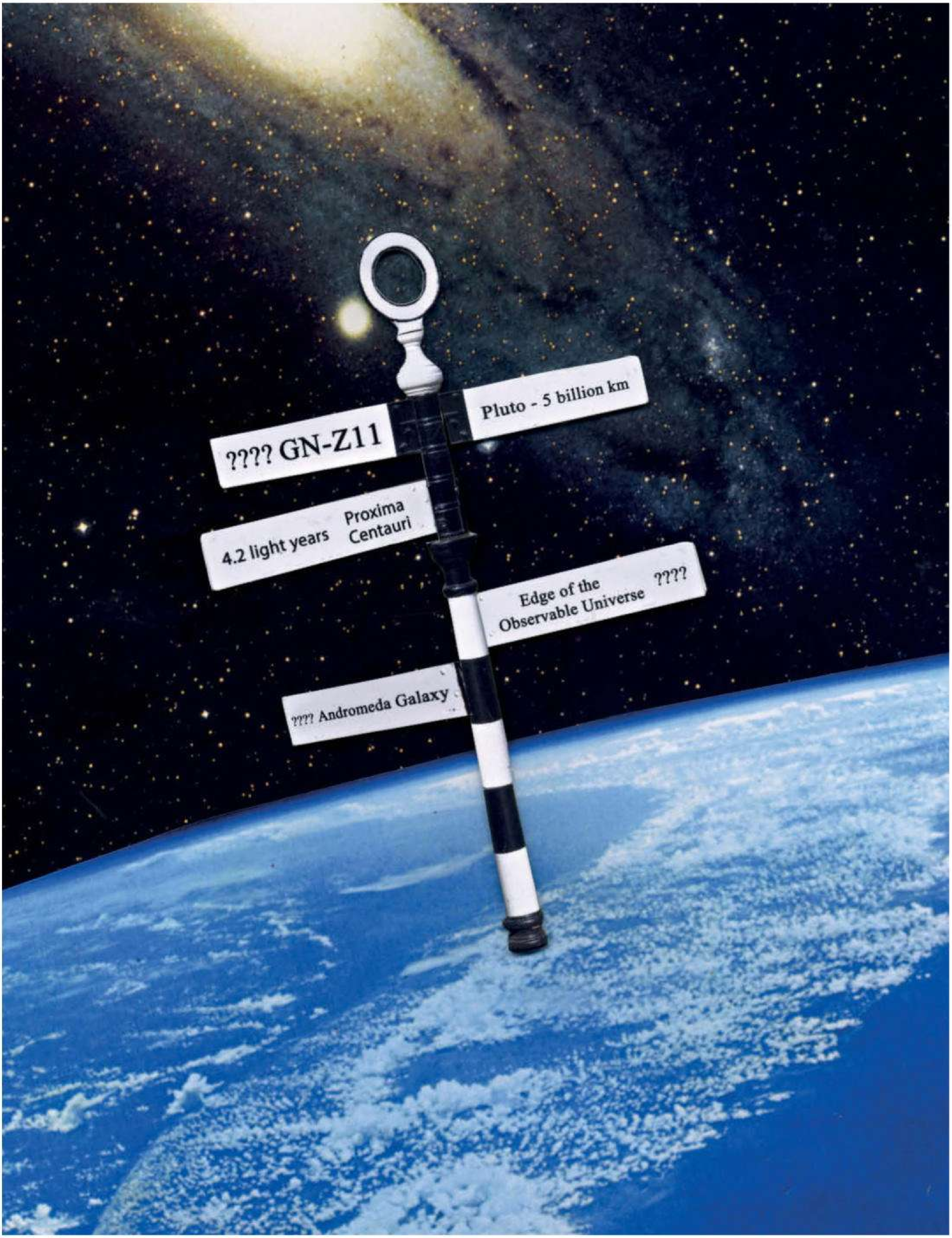
That might include a deeper appreciation and sense of wonder for the multitudes of intelligence around us. “Whenever you ask, is this species cleverer than we thought?, the answer is yes,” says Cooperrider. “It’s like overturning rocks in the stream bed and we’ve only overturned an extremely small percentage of the rocks so far. Every time we turn one over, we find something cool.”

The project could also fundamentally change how we view other species. “Whether or not an animal is intelligent often informs how we think that animal should be practically and ethically treated,” writes Marta Halina, one of the project’s researchers and a philosopher of cognitive science at the University of Cambridge. “Some argue that the ability to act intentionally and flexibly is connected to autonomy, and autonomy is sufficient for personhood.” Personhood, in turn, might entitle an animal to legal protections. Already, lawyers have argued in court cases that chimps deserve rights usually reserved for humans, including freedom from unlawful incarceration – although unsuccessfully so far.

We might even learn something about ourselves by trying to work out where we sit on a periodic table of intelligence. Humans don’t outperform other species as much as you might think. Take Ayumu, a chimpanzee taught to remember random sequences of nine numbers that a screen flashes at him for only 60 milliseconds – less than the blink of an eye. Humans don’t do very well at this task. But Ayumu easily types out the digits in the right order. Once, he competed against the world memory champion Ben Pridmore – and won handily.

Despite such shortcomings, human intelligence does seem to be special, and constructing a periodic table might help highlight how. “There is something different about it because other organisms on this planet are not having conversations about this,” says Barron. “I don’t think it’s a story of human exceptionalism. But there is something interesting about human intelligence and it will be lovely to understand what that is.” ∎

Ute Eberle is a science journalist based in Baltimore, Maryland


Pluto - 5 billion km
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Proxima Centauri
4.2 light years
Edge of the Observable Universe
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???? Andromeda Galaxy

BEN GILES

Distance unknown

Physicists have been arguing over the speed of the universe's expansion for decades – but have they been measuring space wrong all along, asks **Leah Crane**

WENDY FREEDMAN is staring down the universe. For 40 years, she has been digging into the biggest secrets of the cosmos, patiently whittling down uncertainties to find the value of a number that defines the expansion of the universe, determines its age and seals its ultimate fate.

Freedman, who works at the University of Chicago, studies the Hubble constant, a number that represents how fast the expansion of the universe is accelerating. We have known about this escalating expansion since 1929, when US astronomer Edwin Hubble found that the more distant an object was, the faster it seemed to be moving away from us.

That is when things got tricky. Pinning down the numbers requires accurate measurements of astronomical distances. In Hubble's era, astronomical images were taken by shining light through a telescope onto a photographic plate. Calculating distances from those images was difficult and imprecise.

In the 1980s, as Freedman was finishing her PhD, digital photography was getting ready to revolutionise astronomy as a whole, and measurements of the Hubble constant in particular. "That's really what spurred me," says Freedman. In the decades since, her work has been key to the development of the Hubble tension – the perplexing way that the two main ways of measuring the Hubble constant give us different values.

Now, after Freedman has spent decades focusing on this problem, something curious is happening. Her newest results suggest there may be no problem after all. If this is the case, it will render pointless decades of work exploring new physics that could explain the discrepancy. Luckily, Freedman isn't afraid of a little controversy.

The Hubble constant is a big piece of the cosmological jigsaw that, when put together, tells us about the history and future of the universe. If we know how quickly the expansion of the universe is accelerating, that hints how big the cosmos is, how old it is and how it began. Looking ahead, the Hubble constant determines whether the universe will expand forever or collapse in a big crunch.

A cosmic ladder

Before Freedman came on the scene, there were two main estimates of the Hubble constant. French astronomer Gérard de Vaucouleurs found it to be 100 kilometres per second per megaparsec – a megaparsec being equal to 3.26 million light years. But US astronomer Allan Sandage found it to be much lower, at about 50 km/sec/mpc. The two were locked in a fierce debate that had been raging for decades, until the 1980s. At that time, Freedman was a postdoctoral fellow at the Carnegie Observatories in California, where Sandage was a professor. Although well-respected, Sandage was sometimes feared for his anger. He would "go non-linear" when he was contradicted, says Princeton University cosmologist and Nobel laureate Jim Peebles.

When Freedman's first results started coming in from her new observations, they indicated a Hubble constant closer to 80, contradicting two of the most renowned cosmologists in the world. Sandage wasn't thrilled, to say the least. "It's hard being contradicted by a young upstart – what do they know?" says Peebles. "Well, Wendy knew a lot. She is an absolute model of toughness."

You might think it would be a scary place to be, going against the most prominent astronomers of the time. "I didn't find it scary," says Freedman. "It was fun." She knew her results were clear. Her calculations used observations of Cepheids, stars that pulsate regularly. Sandage and de Vaucouleurs used these stars, too. But crucially, Freedman's early observations were among the first to be corrected to factor in the dust between us and the Cepheids, making the calculated distances more accurate than those in previous work.

Cepheids have a pulsation period that is directly related to their absolute luminosity, so comparing that with how bright they appear from Earth can tell us how distant they really are. Those measurements can be used to extrapolate outwards, using supernovae in the same galaxies as the Cepheids. This method is known as the cosmic distance ladder, because each step along the way builds up to the next.

Over the decades since her initial results, Freedman's measurements have held up. Cepheids have remained the main tool by which we measure the expansion of the universe in the area relatively close to Earth – one of the first steps on the distance ladder. ›

In fact, observing them, and measuring the Hubble constant to 10 per cent accuracy, was one of four so-called key projects of the Hubble Space Telescope, launched in 1990. “The director of the project asked, if Hubble fell into the ocean a month after it started observing, what were the projects we’d really want done,” says Freedman. “Every telescope has a big project that’s its goal, and settling this debate was the big problem that was sort of before us.”

The project was a resounding success. Using the telescope, Freedman’s team measured a Hubble constant of about 72 km/sec/mpc – right in between the earlier estimates. Even as instrumentation has improved since the key project paper was published in 2001, the value we get from measuring Cepheids has remained similar, with the most recent observations putting it around 73 km/sec/mpc.

But that isn’t the end of the story, because Cepheids aren’t the only way to measure the Hubble constant. Another problem came along when astrophysicists started observing the cosmic microwave background (CMB), relic light left over from the moments after the big bang. By observing this light and extrapolating forwards in time based on our best models of the universe, we can predict what the Hubble constant ought to be today.

“The CMB is really predicting the Hubble constant starting at the other end of the universe, using our story of cosmology and physics,” says Adam Riess at Johns Hopkins University in Maryland, who won a Nobel prize for his work on the expansion of the universe. And these measurements from the other end of the universe, which are extraordinarily precise, don’t agree with the measurements from this end. They put the Hubble constant at around 67 km/sec/mpc.

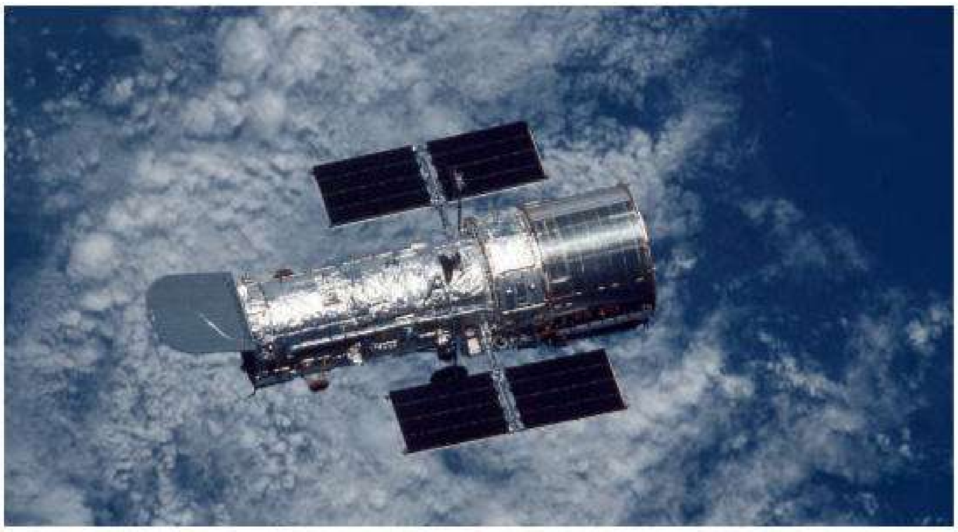
While the CMB measurements themselves are extremely precise, the value of the Hubble constant we get from them is calculated using physicists’ standard model of the cosmos – a set of equations that fit just about everything, from general relativity to the effects of dark matter. “I continue to be astounded at how well theory and observation fit,” says Peebles. “But eventually, we’re going to find something that doesn’t fit, and maybe this is it.”

Tension or no tension?

If both the Cepheid measurements and the CMB measurements are correct, a problem known as the Hubble tension, then something is wrong with our understanding of the cosmos. And if we shift one part of that understanding – for instance, the way the universe inflated after the big bang – it won’t just solve the Hubble tension. It will have a knock-on effect on other factors, in ways we don’t know how to account for. “If anything changes, it’s going to change everything,” says Freedman.

The big question now is whether it is time to change everything. Riess claims that it is. He says the CMB measurements are solid. His group has made many Cepheid measurements, and the tension between the two methods remains. “It’s hard to ignore that basically all the precise measurements are coming in higher than the CMB,” he says.

Other cosmologists aren’t so convinced, not least because of how difficult it is to explain how the two values could be different.


NASA

Measuring the Hubble constant was a key project for the Hubble Space Telescope

DAN ZAFRA (HTTPS://CAPTURETHEATLAS.COM)

“People are trying to come up with ways to explain this, and almost 1000 papers later, they haven’t,” says Freedman. “It’s much more interesting to say there’s new physics than there are systematic uncertainties, but that doesn’t mean it’s how the universe is.”

Nailing down whether the Hubble tension is real needs more measurement methods, says Freedman. Relying solely on Cepheids, it is impossible to know if we are misunderstanding those stars in some basic way that throws measurements off. The uncertainties in the CMB measurement are below 1 per cent. Ideally, uncertainties in measurements of the local Hubble constant would be similarly low. “Right now, there’s disagreement about the errors of the errors,” says Freedman – it isn’t clear where exactly the uncertainties are now, but she doesn’t believe we are at 1 per cent yet. “I think to be certain that the errors are less than 1 per cent, you need more than one type of measurement, more than one instrument, more than one technique,” she says. “I just think we need to be a little bit patient.”

That is why Freedman turned to a different source, called tip of the red giant branch stars. These are the brightest stars in a group called the red giants, which make up a branch on the Hertzsprung-Russell diagram, a plot of stars’ temperature against their luminosity. Tip

Certain stars help us work out the distances to galaxies beyond the Milky Way

> **“It is more interesting to say there is new physics, but that doesn’t mean there is”**

of the red giant branch stars are simpler than Cepheids, and we have a better understanding of the physics that determines how bright they are and their colours. They are also extremely common and located throughout galaxies, whereas Cepheids are generally more concentrated towards the centres. This means we don’t have to worry too much about other stars or dust contaminating our images, as we can simply look at stars that are in less busy areas.

These stars have been used to measure distances for a long time, but they fell out of favour because they are dimmer than Cepheids. Now that telescopes have improved, the simpler stars are coming back to the fore. “This method has always been there, sort of looming in the background,” says Barry Madore at the Carnegie Institution for Science in California, Freedman’s husband and frequent collaborator. “Its simplicity is just crushingly, mind-blowingly good. There are so few things that can go wrong with it.”

So when Freedman’s most recent measurements using the tip of the red giant method yielded a Hubble constant of 69.8 – right between the CMB and the Cepheid numbers – it sowed fresh seeds of doubt among the growing certainty in the community that believe in the Hubble tension. “It was quite a surprise that she came up with these results that are in between, and sort of mitigated the growing feeling that we had that there really was an issue,” says Brent Tully at the Institute for Astronomy in Hawaii. “I think that Wendy makes a good case that there are still outstanding problems.”

Once again, Freedman finds herself at the centre of the debate. “We imagined that when we got our result that it would land on one side or the other, but it just didn’t,” says Freedman. “It’s saying this isn’t really tied up yet.” Not everyone agrees – Riess in particular still claims that it actually is tied up, and the Hubble tension is real – but Freedman remains cautious.

And once again, the solution may come from a huge new space telescope. This time, it is the James Webb Space Telescope (JWST), which launched at the end of 2021 and is expected to begin observations around July this year.

The JWST has a larger mirror than Hubble, so it can look at more distant objects, and unlike Hubble, the JWST is an infrared telescope. That isn’t ideal for Cepheids, which are relatively blue in colour. It will help us improve the precision of our current Cepheid observations, but it is unlikely we will find any more distant ones. The tip of the red giant branch is a different story. As their name suggests, these stars are red, so when viewed in the infrared, they appear brighter than the surrounding stars. “I think that we’re really gonna nail this thing through the tip of the red giant branch,” says Tully.

Freedman has been approved to observe those stars with the JWST once it starts up, and in the meantime she is observing them and Cepheids from the ground, as well as looking into a potential new method using stars that are extremely rich in carbon. “If you knew the answer, you’d stop,” says Madore. “We don’t know the answer.”

The solution to the Hubble tension may come from measurements, but it will be deeply entangled in theoretical calculations about the cosmos as well. “You can’t just measure your way to an answer – these things go hand in hand,” says Riess. If the tension isn’t real, we need to figure out what we misunderstood in the first place. If it is real, there is a far deeper well of misunderstandings. Should we learn that our standard model of the universe is incomplete, we will doubtless find other places where that model breaks down.

“If the Hubble anomaly is real, then there have to be other anomalies,” says Peebles. To build a better model of the cosmos, we will have to hunt each anomaly down, prove it is real and figure out where it came from. All this means more hard work, and more waiting. But Freedman doesn’t mind – it’s business as usual for her. “The universe is doing whatever it’s doing,” she says. “It doesn’t care when, or whether, we answer our questions about it.” ■

Leah Crane is a space and physics reporter for *New Scientist*. Follow her on Twitter @DownHereOnEarth

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The science of cooking

Culture that keeps on giving

The benefits of yogurt are manifold, and the best part is you can make as much of it as you want, says **Sam Wong**

Sam Wong is assistant news editor and self-appointed chief gourmand at New Scientist. Follow him @samwong1

What you need

Food thermometer
1 litre milk
1 tbsp yogurt

The science of cooking appears every four weeks

Next week

Stargazing at home

SHUTTERSTOCK/ROZDEMIR

THE idea that we can improve our gut health by eating foods containing live "friendly" bacteria, or probiotics, dates back to the early 20th century. Ilya Mechnikov, a Russian biologist whose work on immunity led to a Nobel prize, postulated that consuming soured milk fostered beneficial bacteria in the intestines. He claimed that people in Bulgaria who ate yogurt lived longer as a result, and his ideas helped to popularise yogurt in western Europe and North America.

The main types of bacteria found in commercial yogurt are *Lactobacillus delbrueckii* subspecies *bulgaricus* and *Streptococcus thermophilus*. Several studies have found that these bacteria can survive passage through the human gut. It is difficult to isolate the health effects of individual foods, but studies have found that eating yogurt is linked to lower rates of cardiovascular disease, diabetes and obesity, and also to higher diversity in the gut microbiome.

In the yogurt-making process, these bacteria metabolise the sugars in milk and produce lactic acid, which causes the milk to curdle. Casein, which makes up 80 per cent of the protein in cow's milk, is usually bundled together in small particles called micelles. The proteins on the surface of the micelles have a negative charge, making them repel each other. But when the lactic acid causes the pH to drop below 5.5, the micelles start to fall apart, and some of the proteins lose their negative charge. This allows the casein proteins to join together to form a gel – aka yogurt.

To make your own yogurt at home, you will need some shop-bought yogurt to provide the bacteria for the fermentation. Make sure you choose one that contains live bacteria.

Heat up the milk in a saucepan to between 82 and 88°C and keep it in that range for about 15 minutes. This kills off unwanted microbes and makes the whey protein beta-lactoglobulin lose its shape. Deformed beta-lactoglobulins help the caseins to bond more loosely, giving a smoother gel.

Then let the milk cool to a temperature of around 45°C, which is ideal for the yogurt bacteria. Mix a little of the warm milk with the yogurt, then mix this in with the rest of the milk.

Next, you will need to keep the culture warm – between 30 and 45°C – for several hours. Use a sous-vide circulator or a slow cooker if you have them. Or you can put the milk into insulated flasks, a clay Indian yogurt pot or glass jars wrapped in towels. Put the containers in a switched-off oven with the light on, or in a beer cooler surrounded by 45°C water.

It could set in as little as 2 hours or may take as long as 18 hours, depending on the temperature. Once it sets, put the yogurt in the fridge to slow down the bacteria so they don't over-acidify it. It should keep for up to two weeks. ■

These articles are posted each week at newscientist.com/maker

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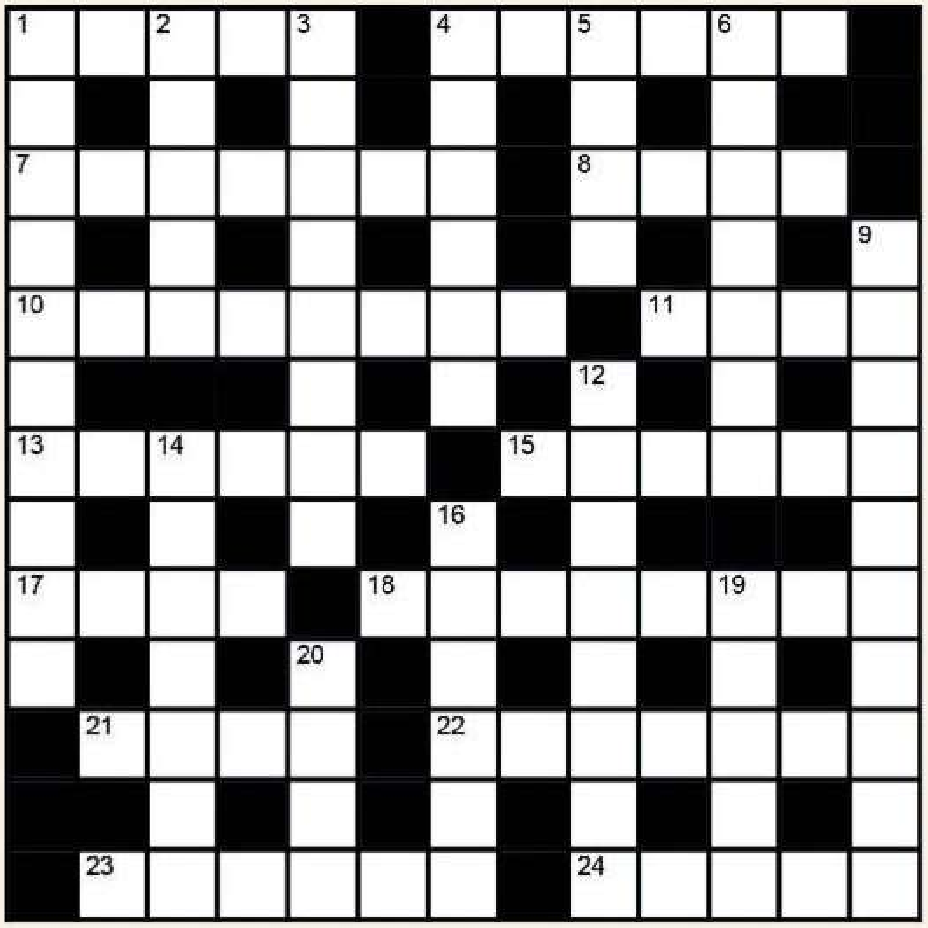
Cryptic crossword #83 *Set by Wingding*



Scribble zone

Answers and the next quick crossword next week

ACROSS

1 Explorer's bed in road (5)
4 Snow vehicle murder reported (6)
7 Sea creature returned phenomenal sample (7)
8 Secure inhabitant of 9 (4)
10 Bag final rock and sleep by fire (8)
11 Maybe cancer is evil overcoming good (4)
13 Send out old wine (6)
15 American Medical Association accepts priest's birth anomaly (6)
17 Sound from farmyard gets zero publicity (4)
18 Awfully thin copy that'll put you to sleep (8)
21 Bird in valley finally lost (4)
22 New Jersey investigator starts trailing bad dog (7)
23 Deduces how Neanderthals might have dressed, according to speaker (6)
24 Seaweed beside a water wheel (5)

DOWN

1 Explorer showing restraint by not going north (10)
2 Round, large and kind of fat (5)
3 You might wear these to tango on stimulants? (8)
4 Fish is behind sulphur smell (6)
5 Fragment of C-type asteroid at a bearing of 90 degrees (4)
6 Rearranged gala infiltrated by spies moving slowly (7)
9 Train cat to dance around somewhere chilly (10)
12 Surprisingly, nude man's first to reach the pole (8)
14 Writer with weapon captures one inhabitant of 9 (7)
16 Shrubland where boys play with nitrogen south of France (6)
19 Singer is content (5)
20 Look in empty fridge for ice (4)

Our crosswords are now solvable online
newscientist.com/crosswords

Quick quiz #151

1 Which type of electromagnetic wave has the shortest wavelength?

2 In which organ would you find the loop of Henle?

3 What is the hibernation-like state entered by animals such as hummingbirds?

4 Which element was long considered to be the heaviest stable element in the periodic table, until it was discovered to be weakly radioactive in 2003?

5 Hydrocortisone is a synthetic, medicinal version of which naturally produced hormone?

Answers on page 55

Puzzle

set by Brian Hobbs

#167 This escalated quickly

At the shopping mall, while their mother's attention is conveniently fixed on a window display, Jill furtively approaches her brother.

"Hey, what do you say to a race up to the next floor and back? Winner does the other one's chores."

"You're on," says Jack.

There are two escalators that move at the same speed, one going up and one going down, and also a regular set of stairs.

The children decide that each will choose on which of the three they want to race, but whatever they pick, they will have to run both up and down on that choice. Jack knows he can run upwards and downwards at about the same speed (and much faster than the escalator).

Which of the three methods should he choose for the race: the up escalator, the down escalator or the stairs?

Solution next week

Moon swap

If the substance that the moon is made of was instantaneously changed to green cheese, what would the consequences be?

Alex McDowell
London, UK
Green cheese – which refers to fresh, unmatured cheese rather than the food's colour – would evaporate in the vacuum of space, especially when the sun shone on it, because the moon's surface can reach up to 120°C.

Cheese is composed of water, fat, protein and lactose, and although water is its most volatile component, the other elements would also evaporate over time.

The density of the moon is about three times that of cheese. Hence, if the volume remained the same, the cheese moon's mass would be about a third that of our current moon. The pull of its gravity would therefore be weaker and the height of tides on Earth would be reduced, even before any of the cheese moon evaporated.

> **"If the moon were ripped apart, maybe Earth would end up with a Saturn-type ring of desiccated cheese fragments"**

Our moon also stabilises Earth's axis, so there would be shifts in our axis if the moon were changed from rock to cheese. If one of Earth's poles pointed at the sun for longer, that would affect life greatly.

Grant Hearn
Cape Town, South Africa
One consequence would be the largest fondue in the universe as the heat generated by the gravitational collapse of the cheese melted and boiled it.

Rachel Tan
Singapore
The water and casein protein, which are the main components of cheese, would begin to separate out, with the caseins moving closer to the core of the moon. As pressure increased, the caseins would start to break down. Nitrogen and other gases would rise up to the surface to create an atmosphere. This could trap sunlight, hence the surface of the moon would be warm enough to form oceans with the water that got separated from the cheese. But since the moon's gravity can't sustain a thick atmosphere, eventually the oceans would sublimate. This would expose a carbon-filled shell that probably wouldn't taste much like cheese.

Hillary Shaw
Newport, Shropshire, UK
This wouldn't be good for life on Earth. The moon would break down into a giant gas cloud, including smaller, volatile, oily molecules, some of which would escape to space. Some of these might form a ring around Earth, causing cooling, and a fraction would end up in our atmosphere and oceans.

I would love a moon's worth of blue Stilton… but then again, maybe not.

Phil Gilbert
via email
As the moon pulls on Earth, it slows down the rotation of our planet. Consequently, the moon recedes from our planet to conserve something called angular momentum. The real moon is currently moving away from us by about 3.8 centimetres every year and Earth's rotation is slowing by 1.8 milliseconds per century. Around 620 million years ago, the day was only 22 hours long.

A cheese moon wouldn't pull on the oceans as strongly and so the Earth's rotation wouldn't be slowed as much. As a result, the moon wouldn't have receded from us as much either. Sitting closer to us, it would appear bigger in the sky. We would also have shorter days.

Richard Swifte
Darmstadt, Germany
Moon rock is quite dark with an average albedo, or reflectivity, of 0.12. Green cheese is much lighter in colour, so a full cheese moon on a clear night would be dramatically brighter.

In terms of other consequences, cheese has a soft structure, so the tidal effect of Earth's gravity – i.e. the fact that the gravitational pull is greater on the near side of the moon than it is on the far side – would, I suspect, soon start ripping the moon apart.

So maybe Earth would end up with a Saturn-type ring composed of desiccated cheese fragments.

Stephen Wawn
Sydney, Australia
Due to the enormous loss of mass that would occur if the rock of the moon were replaced by cheese, the tidal influence of the moon on Earth's oceans would dramatically decrease, leading to a marked slowdown in the circulation of currents, such as the Gulf Stream. This would result in climate change of unmeasurable magnitude. Also, due to its loss of mass, the moon would move out of its current orbit and Earth would experience untold climate issues as a result of the gravitational loss of its satellite.

David Waring
Farlington, North Yorkshire, UK
The cosmos would immediately start to smell of feet.

SHUTTERSTOCK/BAISMARTIN

This week's new questions

Buzz off **Why do insects like bees and flies buzz when flying? Does expending energy to make this sound help them?** ***Ian Macdonald**, Bath, Somerset, UK*

Ouch **Why is pain so painful? After all, it is only nerve impulses sent to our brains like many others.** ***Ken Wallace**, Melbourne, Victoria, Australia*

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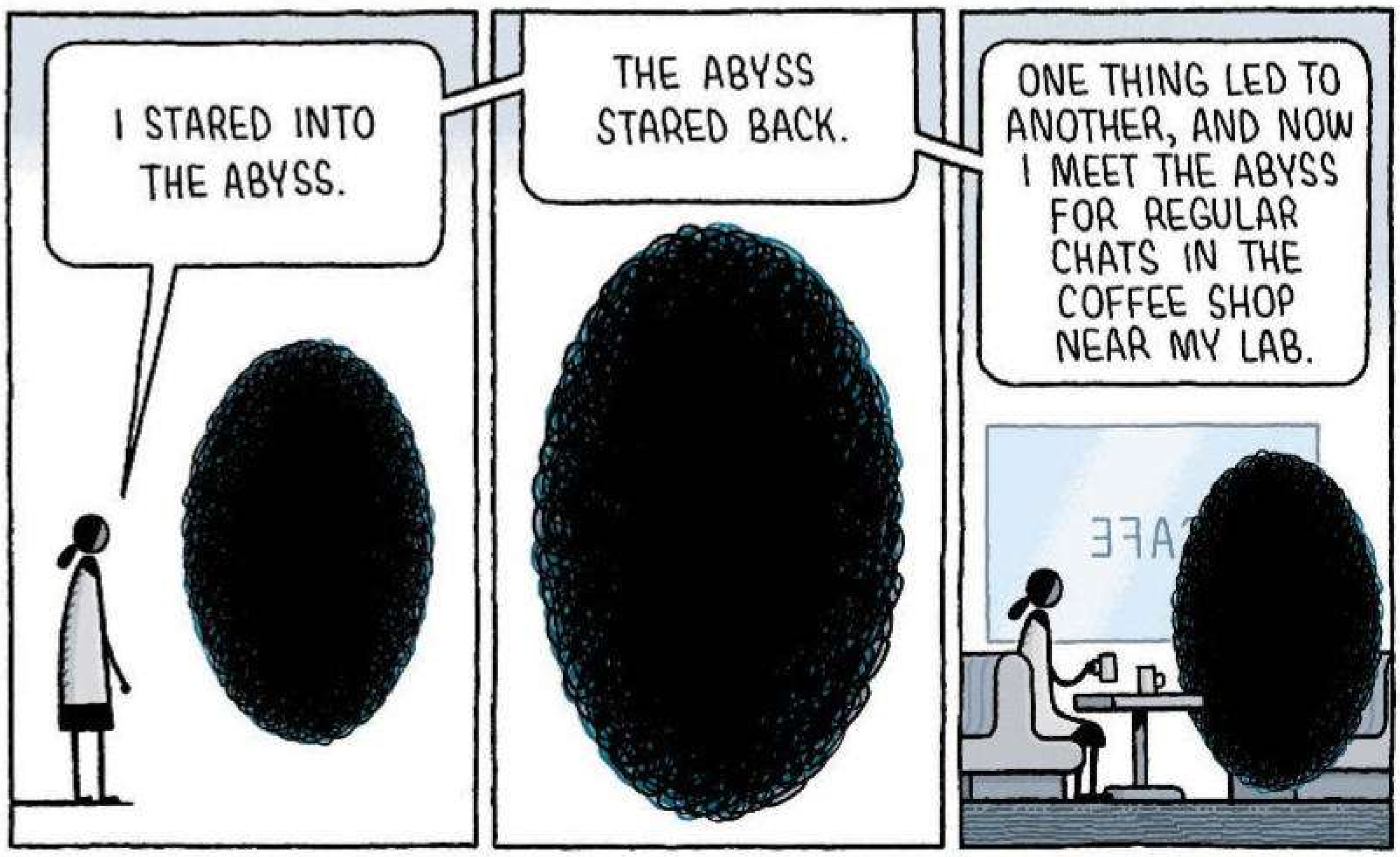
Tom Gauld
for New Scientist


I STARED INTO THE ABYSS.
THE ABYSS STARED BACK.
ONE THING LED TO ANOTHER, AND NOW I MEET THE ABYSS FOR REGULAR CHATS IN THE COFFEE SHOP NEAR MY LAB.

Cutting it

How would prehistoric people have cut their toenails?

John Davies
Lancaster, UK
Our nearest relatives, the great apes, have fingernails that they don't cut, because these are worn away by being used to hunt, dig and scrape a living.

This would have also been true of our prehistoric relatives. Only once farming was invented did life become less hard and so nails needed cutting.

Stephen Arbitter
via email
Besides wear from use, prehistoric people undoubtedly chewed their toenails.

Albert Beale
London, UK
For much of my life so far I have managed quite well without needing any tool to cut my toenails.

When soaking in the bath, I would bite off any excess nail. However, as I have got older, I have become less supple – perhaps because of doing different types or amounts of exercise (I do no yoga these days), or as an inevitability of ageing – and hence have resorted to scissors.

> "Chances are that prehistoric people didn't need to cut their toenails due to the natural abrasion of walking barefoot"

Maybe prehistoric people rarely got old enough to be unable to deal with their toenails as I always used to.

Mike Follows
Sutton Coldfield, West Midlands, UK
Chances are that prehistoric people didn't need to cut their toenails: while they were walking around barefooted, their nails would have been naturally abraded by contact with the ground. This is why toenails continue growing throughout our lives.

Toenails grow at half the speed of fingernails – 1.6 millimetres per month compared with 3.5 millimetres per month in adults, according to a 2010 study. This suggests that there is an evolutionary component to these growth rates, perhaps due to different rates of wear and tear. Interestingly, the growth rate of the nail on the big toe is significantly higher than that of the other toes, according to a 1937 study.

Cutting toenails was certainly required once people started wearing shoes and switched to more sedentary lifestyles.

Apparently, Marie Antoinette used a nail file made of pumice stone, a rock that contains tiny air bubbles and is created by explosive volcanic eruptions. Given that pumice is geographically widespread, perhaps this or something similar would have been picked up and used by prehistoric people to file their nails if necessary. ▮

Answers

Quick quiz #151 *Answers*

1 Gamma rays
2 The kidney
3 Torpor
4 Bismuth
5 Cortisol

Quick crossword #107 *Answers*

ACROSS 1 Motile, **4** Cyberiad, **9** Dredd, **10** Sclerosis, **11** Cube, **12** Mako, **13** Hyena, **15** Residue, **16** Weir, **19** Neon, **20** Gagarin, **23** Insta, **24** Anal, **25** Wiki, **27** Cochineal, **28** Imago, **29** Protease, **30** Cicely

DOWN 1 Medicare, **2** The Abyss, **3** Lode, **5** Yellow Wagtail, **6** Earthlings, **7** Instep, **8** Distal, **10** Space Invaders, **14** Adrenaline, **17** Irrigate, **18** Antimony, **21** Hiccup, **22** Psycho, **26** Kiwi

#166 The week link *Solution*

The days of the week in order are Ardik, Deldik, Curdik, Bordik, Endik, Gandik and Fordik (ADCBEGF). The three orders presented were (1) ABCDEFG, (2) DBACEGF and (3) GDCBAFE, and we know that in each case three are correct.

As nine are correct in total, but there are only seven days in the week, at least two days must be correct in two lists, and since the first guess was in alphabetical order and we know A is the first day, only two more days can be in the correct alphabetical position. This also means that each day must have been named in the correct position by at least one child. The third day can't be A, so it has to be C. This leads to the fourth day being B, the second D and the rest follows.

Toad in the hole

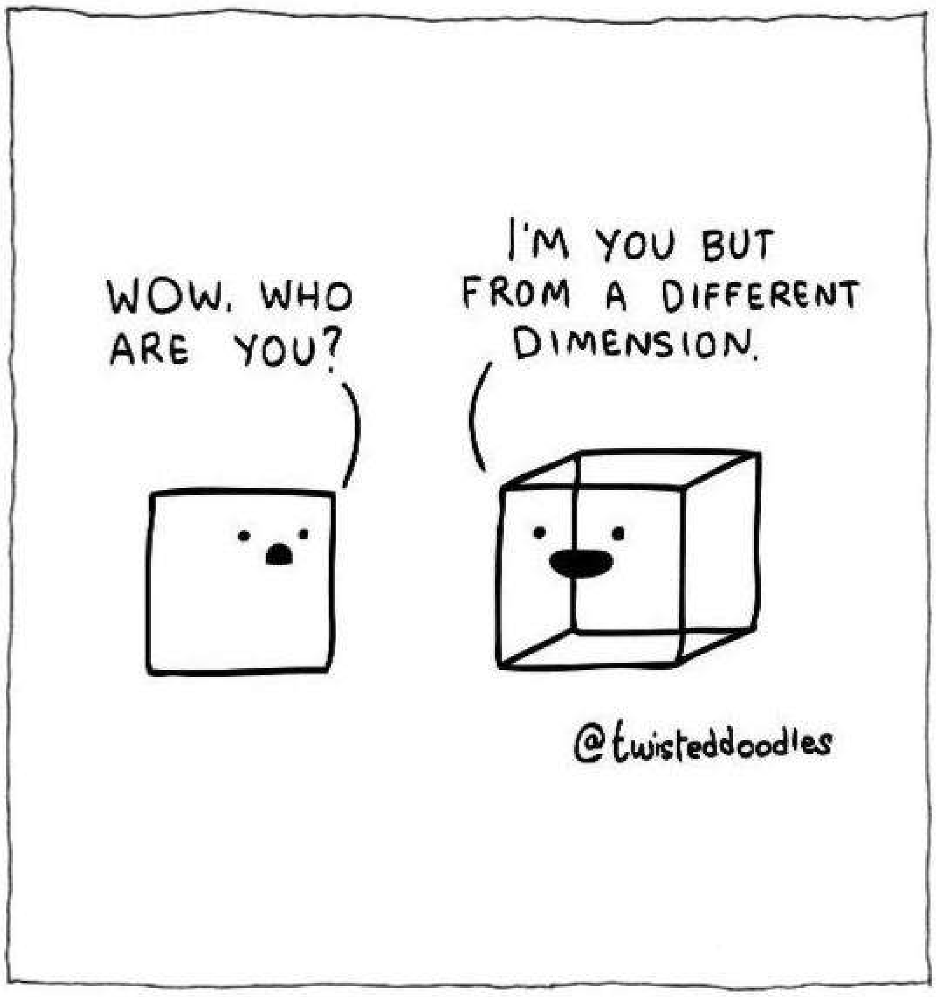
If we are looking a little lorn this week, with our mouth opening and closing to little effect, it is principally because we are staring at "Finding love in a hopeless place: A global database of misdirected amplexus in anurans". This is a new paper in the journal *Ecology* by Filipe Serrano and his colleagues at the University of Sao Paolo in Brazil. No amount of science words can gloss over the fact that it amounts to a spreadsheet of all the instances recorded in the scientific literature in the past century of frogs attempting to mate with things that they shouldn't.

It can't be easy being an amphibian, as evidenced by the touching – in a very real, excessive sense – story recently reported in this magazine of male Santa Marta harlequin toads in Colombia that cling to females' backs for up to five months in hope of mating (23 April, p 19).

The new database conveniently tags misdirected encounters with hour, month, year and geographical location. "We recorded a total of 282 interspecific amplexus, 46 necrophiliac amplexus and 50 amplexus with objects or non-amphibian species, with USA and Brazil being the countries with the highest number of records," the authors report.

"Why?" asks a colleague. Ah, well, if we knew why we were doing science in the first place, that wouldn't be science, would it?

Twisteddoodles *for New Scientist*


WOW. WHO ARE YOU?
I'M YOU BUT FROM A DIFFERENT DIMENSION.
@twisteddoodles

Got a story for Feedback?

Send it to feedback@newscientist.com or New Scientist, Northcliffe House, 2 Derry Street, London W8 5TT

Consideration of items sent in the post will be delayed

Broken-down wind

Many of us have a special place we go when we want to think. In Feedback's case, we are often accompanied by *Think*, a journal of the Royal Institute of Philosophy that promises "philosophy for everyone".

We think it may be getting a little too Everyman with a contribution in the latest issue entitled "The metaphysics of farts". If the last item brought the sound of the barrel scraping, listen to us now drill right through.

What is a fart? An act, that of breaking wind, or a thing, the resultant smell? Author Brian Capra tackles this question head on, highlighting contradictions between the "essential-bum-origin" and "phenomenological" views that, he submits, mean both can't be true.

Via a thought experiment asking if two people fart in a lift, how many farts there are, and the obvious answer – does it matter? – he concludes that a fart-thing must proceed from a fart-act, but a fart-act doesn't necessarily produce a fart-thing, and, so, "we are led to an outlook similar to Descartes's view of the mind: on the phenomenological view, the essence of a fart is given to us in our olfactory experience".

Desfartes, as a nameless colleague supplies indelicately. Ignore them, dear readers: this sort of thing is what makes philosophy and thinking such valuable activities. Now, could someone open that door? It is closer than two toads in the mating season in here.

Got my goat

We note in passing – noiselessly, of course – that the same author wrote an article in *Philosophy Now* that uses elementary principles of model logic to prove that everything is a goat. For those still asking "why?", we merely note the goat's genus is *Capra*, and there may be more than a hint of solipsism in the argument.

On a roll

We would personally prefer it if everything were cake. Our thanks to the very, very many of you who provided ever so slightly muffled feedback on our recent item on legal definitions of cake (30 April). Space fortunately does permit us to delve into the details, suffice to say that the rigour with which you treat the subject convinces us that Feedback is all one happy family with shared values and priorities.

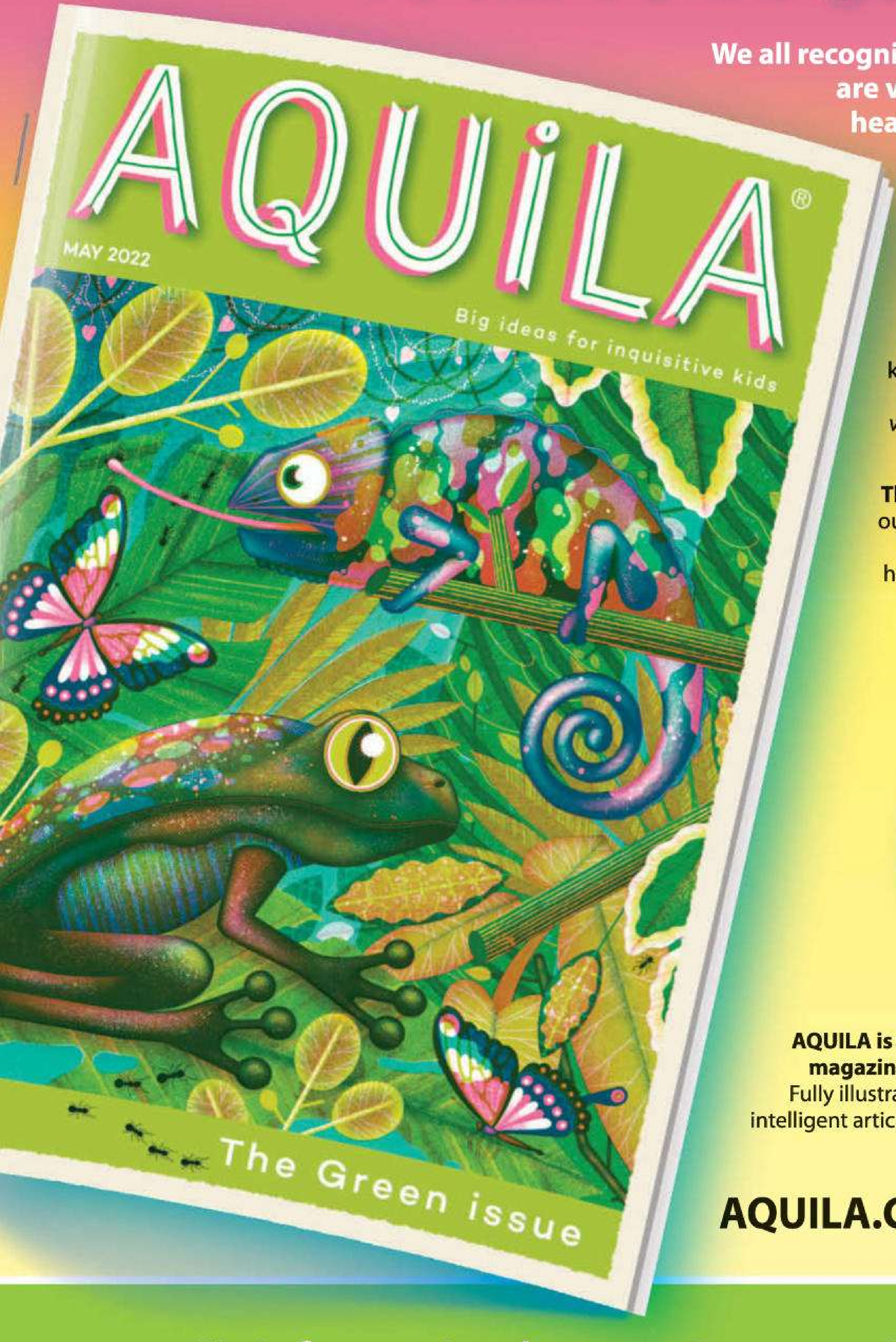
We particularly savoured Liz Tucker's tangential mention of a talk she went to on the history of the Lyons tea-and-cake empire that was a feature of the British landscape for many years, which stated that, at one time, the company produced 35 miles of Swiss roll a week. This conjures a mental image of a truly majestic, if slow-moving, machine. It prompts us to ask "How do you make a Swiss roll?", to which we are sure you can supply the punchline.

Like a lead...

Carl Zetie is perplexed by the appearance in his Facebook feed of an advertisement from a software company called Zeplin, whose corporate logo is an airship of almost that name. "Companies ship 20% faster using Zeplin," it promises. Historically speaking, this seems an odd choice of corporate metaphor, and we do hope there is no crashing and burning on arrival.

Talking tough

Those were unsettling times, as are these. So it is good to know that the defence of the realm is in no-nonsense hands, as per a tweet from the University Royal Naval Unit Edinburgh, sent to us by Ceri Brown. "Our first training evening after Easter was a very detailed and informative brief from the Defence Nuclear Organisation on the UK Nuclear Deterrent. Thank you to Captain Tough and his team for the briefing." With that exemplar of The Name Thing That Shan't be Mentioned, and to employ a military phrase whose correct usage has generated lively debate from you before (3 April, 24 April and 8 May 2021), it is, from this Feedback, over and out. ▮



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